SCIENCE EDUCATION

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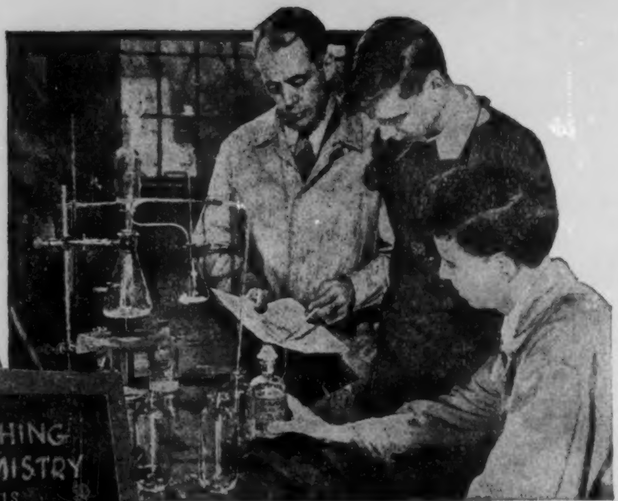
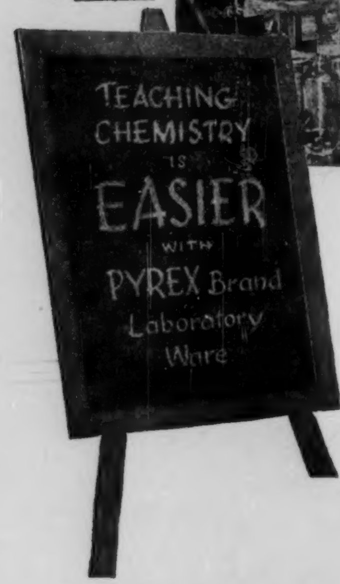
VOLUME 35 DECEMBER, 1951 NUMBER 5





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JUNIOR AND SENIOR HIGH SCHOOLS, COLLEGES,
AND PROFESSIONAL SCHOOLS FOR TEACHERS

VOLUME 35 DECEMBER, 1951 NUMBER 5

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INTRODUCING THE CONTRIBUTORS

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For the past ten years, Dr. Paul F. Brandwein has been chairman of Science at the Forest Hills High School and on the staff (part-time) at Teachers College, Columbia University, teaching courses in methods (Methods of Teaching General Science; Biology) and courses in a program of general education in science for teachers (Biology and Man). Also concurrently, for the past four years he has been Science Editor for Harcourt, Brace & Co., with the specific object of editing a series of science books for purposes of general education. He holds the degrees AB., M.Sc. and Ph.D.; the latter was in Biology (Plant Pathology) with work taken at New York University, Columbia, and the Brooklyn Botanic Gardens. His publications consist

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SCIENCE EDUCATION

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MAKING TEACHING ATTRACTIVE

IDA T. SMITH

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MUCH has been said and written in recent years about the "teacher shortage." Laymen and professional groups alike have expressed deep concern about the limited number of young people preparing to enter the teaching profession and the great number of teachers withdrawing from it to enter other areas of work. Much has been written concerning the increased number of children of school age in the nation and the need for an ever-increasing number of teachers. In 1949 only one teacher was being prepared for every five that were needed. In a recent statement, Earl J. McGrath,[1] United States Commissioner of Education, stated that "by 1960, the nation will need 750,000 new teachers and that 100,000 of those now teaching are not qualified for the jobs they hold." Such statements make self-evident the need for encouraging more young people to enter the profession.

Probably at no time in the world's history has there been a greater need for efficient teachers of the nation's youth who will be the nation's leaders of tomorrow. Henry Adams said, "A teacher affects eternity. No one can tell when his influence stops." George Tomlinson, English Minister of Education, stated, "If there were no teachers in the world, the world would be back in barbarism in two generations." H. G. Wells said, "Human history becomes more and more a race between education and catastrophe." If such statements are true in time of peace, how much more true do they become in time of unrest, uncertainty, and world turmoil such as the present.

No nation in the world has had greater faith in education than has the United States and no other nation has ever achieved her level of society. From the country's very inception, education has played a major role in developing the "American Way of Life." Americans have always believed that democracy was dependent upon an enlightened electorate, and that education was essential to the amalgamation of the many parts of the country and the many diverse population elements. Americans have always believed that education leveled economic and social barriers to advancement and that democracy, nationalism, and Americanism developed as education spread and grew.

On the other hand, no nation in the world has demanded as much of its educators as has the United States. The people of this country have given its educators the responsibility for the *whole* child, not merely the responsibility for his academic progress. They want their schools to teach the "3 R's"—and—morals, ethics, racial and religious tolerance, and even sex and marriage. They demand vocational, practical, cultural, and character education. They want their children taught to think. All this they entrust, with confident faith, to the American public school teacher!

Why then, is it so difficult to attract young people into the teaching profession?

[1] *Tulsa Daily World*—AP Dispatch, September 29, 1951.

How can teaching be made more attractive to those young people who are best fitted to become the kind of teachers America needs to preserve her existence? Mere numbers is not the real answer to the question.

There are at least two groups of people responsible for the teacher shortage—the public and the teachers themselves. Society has done much, despite its faith in education, to discourage young people from entering the profession.

1. For years society, in its imagination, has built a wall around the teacher. It has set teachers apart from the rest of society. It has made the teacher the consummate exemplification of its dreams—an ideal person, ideally prepared to guide its children. Society has surrounded the teacher with restrictive mores similar to those established by certain religious groups who renounce the world and retire from its practicalities. In many communities teachers are expected to refrain from card playing and other social activities in which the rest of the community engages. In some places women teachers must remain single and men teachers must be married. There are still some places that demand that a teacher sign a written statement agreeing to remain in the community so many week ends each month and attend church a given number of times. There are communities which demand that the teacher do all his shopping in the community. Desirable as these things may be, is any other group of workers or professional people so restricted? There are communities in which teachers are told how they may dress, when they may go to the movies, and what hours they are expected to be at home. True, these restrictions are less prevalent than in the past, yet teachers are still being set apart from other persons in the community and their personal lives are certainly less than private.

2. In the recent attempts to improve the economic lot of the teacher (and it has needed improvement) the hue and cry of "Lo! The Poor Teacher" has echoed over the land. Newspapers, magazines, movies, and radio have all stressed the poor pay, the lack of security, and the undesirable working conditions which have been the lot of the teacher. The public has "pitied" the teacher. It is true that the public had to be made aware of the handicaps under which teachers were laboring and the inequalities existing between teaching and other professions, but no other profession has permitted its problem to be presented to the public in such undignified and unprofessional ways. Out of this pity and commiseration came some good for those already engaged in teaching, but it is extremely doubtful that many desirable young people were attracted to the profession by it.

3. Movies, radio, and books have long caricatured and ridiculed the teacher. The teacher is still presented through these mediums under the guise of, "Those who can, do; those who cannot, teach." Teachers are typed as: old maids (of either sex), martinets, frumps, muddle heads, idealists with their heads in the clouds, absent-minded professors—in other words, "freaks." Seldom are teachers portrayed as real, human, intelligent, normal, social beings engaged in one of the greatest services to mankind. Alert, intelligent, fine young people do not wish to become oddities.

4. The public has lost sight of the fact that teachers, to be effective, must be accepted as members of the community and that their needs must be met. Teachers need recognition. Their services to the nation should be publicized. They should be given credit for the good that they do. Instead, today, most of the publicity given to teachers and teaching is critical and detrimental. All the faults of today's society are laid at the feet of the teachers.

Teachers need security—intellectual, occupational, and financial. They do not have intellectual security. Teachers can "think" only within certain accepted tenets. Any divergence from the common thinking of the community results in loss of position. They do not have occupational security for

only about three of every five teachers in the United States is under legal job protection. Only six states have tenure, and even under tenure no teacher is safe for the job can always be eliminated. Teachers do not have financial security. It is true that during the period from 1938 to 1950, teachers' salaries rose almost 80 per cent; but, during the same period, the salary rise was approximately 120 per cent in other occupations.

The teacher's needs for companionship, social life, friendship, and acceptance are not being met.

Until communities recognize and meet teachers' needs, desirable young people will not be attracted to the profession, and many fine people already in the profession will leave it.

Although the public is responsible for some of the lack of teachers in the nation's schools, it is by no means responsible for all of it. Teachers themselves are to blame for much of the shortage.

A famous educator once said, "As the teacher thinketh, so is he; as is the teacher, so is the school." What teachers *are* is of fundamental importance.

If society is to change its concept of teachers and cease pitying them and looking down upon them, teachers must cease pitying themselves and become the kind of people who command respect and inspire others to want to imitate them. If desirable young people are to be attracted to the profession, teachers themselves must become more attractive, more worthwhile, and more dynamic. Arthur Guiterman says,

> "No printed word or spoken plea
> Can teach young hearts what men should be,
> Nor all the books on all the shelves,
> But what the teachers are themselves."

1. Teachers must be more attractive, more competent, and more professional. To be more attractive teachers must be better human beings, more like other socially desirable persons. They must be healthy, mentally and physically. They must be more personally attractive, clean, neat, reasonably fashionable, well-groomed, and appropriately dressed. Teachers must be well-adjusted and happy; they must be secure within themselves. Teachers must be social beings, liking people and being liked by them. They must have culture, refinement, enthusiasm, courage, imagination, and intelligence. They must be well-mannered, poised, interested, and interesting. Teachers must be generous, giving freely of their time, talents, interest, and knowledge. They must be ethical, inspirational, and conscientious. They must have self-control, tact, patience, and a sense of humor. Teachers must be well-informed seekers after knowledge. They must be able to talk interestingly on many topics and to participate intelligently in community life. Teachers must be understanding and sympathetic; they must have faith in people and their ability to grow and develop. Teachers must be human beings, not paragons, but with sound character, good citizenship, and belief in democratic principles.

Such a person is welcome in any community and any worthwhile activity not because he is a teacher, but because he is the kind of person who helps to make the community a better place to live.

2. Teachers must become more efficient, more competent, in their chosen occupation. Too many teachers today belong to that group of practitioners who are interested only in subject matter and traditional materials, methods, and products. Another large group speak platitudinously of child needs, child interests and activities, and love for children, forgetting that knowledge and skills are also essential to the proper growth and development of children. The extremists of either type help foster the belief that school teachers are impractical. One factor decreasing the effectiveness of teacher training lies in the practice, in many schools, of sending to the school of education those who flunk out in other schools and divisions. Too many schools of education are training young people who plan to use teaching only as a stepping stone to something which they feel is more desirable.

Lack of college facilities, large classes, limited materials, poor pay for college teaching, poorly trained college staffs—all these are in a measure responsible for the ineffectiveness of many of today's teachers. A good teacher must be more than a pedagogue and more than a master of subject matter. A good teacher should never have to say, apologetically, "I'm just a teacher"; he should be able to point with pride to his profession and his efficiency and say, "I'm a teacher." Only as teachers themselves demand greater competency from their fellow workers and themselves can they expect the public to recognize their competency and effectiveness.

3. Yet, a teacher might be a fine human being, with fine technical skills in teaching, and still not be the kind of person who would inspire others to enter the teaching profession. Teachers must take pride in their profession and further all efforts to make teaching truly professional. Professionalism is more than belonging to professional organizations; it is more than reading professional literature and attending professional meetings. Fundamentally, it is a point of view—a way of life. According to experts, working with ideas and people represents a high level of living. If this is true, surely teachers are working on a high level. Furthermore a teacher's work is measured qualitatively rather than quantitatively; a teacher's work is measured less in terms of immediate results and more in terms of long term or deferred values. A teacher's work is not limited by hours or the four walls of the classroom. Literally it has no beginning and no ending and no material barriers. It cannot be measured and paid for in terms of objective achievement, but rather the teacher's work and accomplishments are an outgrowth of the teacher's professional conscience. To be a professional teacher one must want, above all else, to be a teacher; one must be willing to accept the responsibilities of teaching; and one must be willing to wait for deferred rewards rather than to expect immediate pay. There is no place in the teaching profession for members of the FTG Club, for clock-watchers, for self-pitiers, or for those whose only concern is Self.

Only as teachers improve themselves as people, as classroom technicians, and as professional workers can they command and expect the respect of the public. Only as they achieve respect in the eyes of the public can they expect desirable young people to be influenced into wanting to become members of the profession.

Pearl Buck said, "Only the brave should teach; only those who love teaching should teach, for teaching is a vocation. It is as sacred as priesthood; as innate a desire, as inescapable as the genius which compels a great artist. Indeed a true teacher is a priest and an artist. If he has not the concern for humanity, the love of living creatures, the vision of the priest and the artist—he must not teach."

Young people will find the teaching profession attractive only when teachers themselves, and the general public, recognize teachers as socially attractive, occupationally effective, and professionally competent.

THE STATUS OF PHYSICS IN OKLAHOMA HIGH SCHOOLS OF 1951

MAX V. MANEVAL
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DURING the school year 1950–1951 a questionnaire was sent to fifty-one high schools of Oklahoma that were teaching physics in 1922. Of those questionnaires returned, only thirteen were still teaching physics. A comparison of various factors in these schools was made with information presented in a thesis completed in 1922.[1] This comparison was used as a seminar study at Oklahoma A. and M. College during the summer of 1951.[2]

Using the thirteen schools as a basis for the study, it was found that the ratio of boys to girls has more than doubled from 1922 to 1951. During the same period of time it was found that the percentage of the high school students enrolled in physics courses has decreased from 8.3 per cent to 4.5 per cent.

The average number of laboratory experiments is now over fifty a year. This is a fifteen per cent increase in the number of experiments performed during the year while there is a nearly one-third decrease in the number of students working in one group in the laboratory. The average value of apparatus per student has more than tripled. The laboratory phase of physics appears to have improved much in the twenty-nine years between these studies.

Physics instructors in 1922 taught many subjects not related to their major in college; fifty per cent of them majored in subjects which were not related to physics. The recent survey showed that all physics instructors majored in science and mathematics in college and are teaching only science and mathematics in high school.

The U. S. Office of Education made a survey in 1947 of the science courses in representative high schools of the United States.[3] This survey reported 5.49 per cent of the nation's high school pupils enrolled in physics in 1947. The questionnaire of 1950–1951 in Oklahoma showed 4.5 per cent enrolled. A previous survey in 1922 showed 8.93 per cent enrolled in physics in the nation, with Miss Sielinger finding 8.3 per cent in 1922 in Oklahoma. Even though Oklahoma has decreased in its physics enrollment, this decrease is very consistent with the national average.

The ratio of boys to girls in the physics classes of Oklahoma in 1950–1951 was 4.5 to 1. The national ratio in 1947 was 2.45 to 1.

From the data available it appears that in some respects Oklahoma high school physics courses have made marked improvement since 1922, although fewer students are enrolled in physics. The percentage of high school students enrolled in physics in Oklahoma high schools is slightly less than the national average, but the ratio of boys to girls enrolled in physics is nearly twice the national average.

[1] Sielinger, Leona. "The Status of Physics in the High Schools of Oklahoma." Unpublished Master's Thesis, School of Education, Oklahoma Agricultural and Mechanical College, 1922.

[2] Maneval, Max V. "A Comparison of the Status of Physics in Oklahoma High Schools of 1922 and 1951." Unpublished Master's Seminar Study, School of Education, Oklahoma Agricultural and Mechanical College, 1951.

[3] Johnson, Philip G. *The Teaching of Science in Public High Schools.* Federal Security Agency, Office of Education, Bulletin 1950, Number 9.

AN EXPERIMENTAL STUDY OF THE EFFECT OF FIELD TRIPS UPON THE DEVELOPMENT OF SCIENTIFIC ATTITUDES IN A NINTH GRADE GENERAL SCIENCE CLASS

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I. INTRODUCTION

FIELD trips, or school excursions, have been used as a teaching device for many years both in this country and in Europe. Since 1920 mention of them is found in the educational literature with increasing frequency. Evidence of their value as a teaching method ranges all the way from unsupported statements of opinion, to a limited number of carefully evaluated studies. Most of the conclusions are to some extent favorable to the worth-whileness of field trips.

However, in spite of this favorable view of the value of the school excursion, the number of reports of junior or senior high school science classes in which the excursion has been used as a regular part of the curriculum are extremely limited, and are largely confined to small classes or private schools.

Field trip used here means a carefully planned and evaluated excursion outside the school building, which is still an integral part of the instructional program, and in which each student may take an active part.

The present study was undertaken as part of the teaching program of a ninth grade general science class in the study of a unit on Conservation. This study differs from the usual investigation in several ways:

1. Unlike most field trips the purpose of this study was not the verification or illustration of information previously acquired in the classroom, but was the acquisition of new knowledge by the use of the scientific method.

2. Since it has been shown that scientific attitudes are not acquired concomitantly with the acquisition of scientific information, but must be taught for directly, and since it is known that functional information is best acquired by having the student actually put into practice the information to be so acquired, this study was designed with a two fold purpose in view:

a. The excursions were so designed as to give the students experience in planning their own trips so as to get the maximum value from them both with respect to their potential educational content, and, in addition, a functional understanding of the scientific method.

b. The trips were designed also to give the students a genuine addition to their real knowledge. In this case the knowledge concerned the evaluation of the results of a common practice in the local community, that of frequent or annual burning over of nearby areas.

3. Both of these outcomes were being sought while a method of teaching for the acquirement of scientific attitudes was being demonstrated.

II. STATEMENT OF THE PROBLEM

This study was undertaken in the spring of 1949 with two sections of thirty-four students each, in a ninth grade general science class of the Stillwater, Minnesota, Junior High School, in connection with the study of a unit on Conservation. The *Control* group experienced regular, comparable classroom procedures of teaching by the same teacher while the *Experimental* group experienced the field trips. A total of four field trips were made, two for the Control section and two for the Experimental section, occupying four regular class periods of

fifty-five minutes each. However, the two field trips made by the Control section were made *after* the final test.

The main problem was to determine whether there was a significant difference in the development of scientific attitudes in the group which experienced the field trips as compared with the group which experienced regular classroom procedures.

"Scientific attitudes" have been variously defined. Because of its availability to the class, the list of scientific attitudes as given by Dr. Otis W. Caldwell and Francis D. Curtis [1] in *Everyday Science* was used as a model. This grouping corresponds closely with the analysis of scientific attitudes as given by Keeslar [2]. The elements of the scientific method as defined by Caldwell and Curtis in "Everyday Science" were also used as a model.

III. DESIGN OF THE EXPERIMENT

This experimental study sought to test the Null Hypothesis that: there is no significant difference in development of scientific attitudes between two sections of a ninth grade general science class, one of which experiences field trips, and the other of which experiences regular comparable classroom teaching procedures by the same teacher.

Selection of the control and experimental groups was made at random.

The Otis Mental Achievement Test had been administered to the entire class prior to the beginning of the experiment, and the results of these tests, the I.Q. scores, were used as one of the matching characters in the comparisons.

The Scientific Attitudes Tests used were those of Caldwell and Curtis [3], plus some teacher-made questions. One half of the test was administered as an initial test, and the other half as a final test, to avoid the influence of recall on the final scores.

Members of both the Experimental and Control groups were given the first half of the Scientific Attitudes test as an initial test. The final test was administered to the Experimental group *after* the completion of the two field trips, and to the Control group *prior* to their experiencing the field trips, but *after* completing their classroom studies.

IV. ORGANIZATION OF THE FIELD TRIPS

One of the main features of the study was the potential educational value which the students received from planning and organizing the field trip study themselves.

Several days before the field trips were to be made, the class discussed methods of organization for the most efficient action, realizing that the time available was limited to two fifty-five minute class periods.

In the class discussion the following facts were brought out regarding the proposed study.

1. The study was to consist in observing and comparing at first hand the evidences of the effects of continual burning over upon an area as compared with a similar area which was known to have not been burned over for at least twenty-five years.

2. The areas to be studied were chosen as being similar in all respects except for the factor of burning or lack of burning. Factors common to both areas were:

a. Situation—near highway about one-half mile from St. Croix River, elevation circa 725–800 feet above sea level.
b. Slope—gentle to steep.
c. Exposure—facing east.
d. Soil—sandy loam (origin Patrician drift deposited over Jordan sandstone).

3. Detailed study was planned for each of the areas as regards plant and animal life to be found in a sample section of each, as well as observations on soil content, texture and moisture and evidences of erosion, surrounding bird life, and any other pertinent observations.

4. Group organization. During the discussion the class decided to organize itself for maximum efficiency in the following manner:

Each section of thirty-four students was to be divided into five groups of seven or six students each, using the classroom rows as a simple basis for grouping. Each group then elected a leader who by the acceptance

of his/her position thereby assumed certain responsibilities for the trips; namely, each leader was to be responsible for seeing that the students in his/her group had the complete equipment for the trips, and were assembled promptly in their seats on the bus. Each group leader also was to be responsible for the selection of a sample plot (with the advice of the teacher), for marking out the plot, and for the overall supervision of the study and collection of samples.

Each student was to carry a pencil and a work sheet to be filled out in part while on the trip, and completed in class the following day. The equipment for each group consisted of a trowel, boxes for specimens, string, four markers, and a yard stick.

Instructions agreed upon in the discussion were that immediately upon the arrival of the bus at the destination of each trip, the groups were to disembark from the bus quickly, assemble under their respective leaders, select a sample spot which was typical of the area under study, mark off a sample plot two feet by two feet, and then collect samples of each different kind of plant and animal to be found within it, as well as samples of the top-soil and subsurface soil. Observations were also to be made of all the other factors mentioned previously, and entered on the work sheet.

Eight minutes were allowed for the bus trip to the unburned area which was four miles from the schoolhouse, two minutes were allowed for pupils to get themselves with their supplies seated on the bus, and the same time on the return trip for getting to the room with their samples and putting them in containers to be moistened for further examination on the following day. This left thirty-five minutes for the field study, which proved to be adequate.

Bus time to the burned over area was only four minutes, as it was only two miles from the schoolhouse. This left a little more liberal margin of time for the study, and as there were fewer specimens to be found here, the time proved to be ample.

On the days following the field trips the material which had been collected and brought into the schoolroom was studied further and identifications completed. The laboratory work sheets were filled out, lists for each area were compiled, comparisons made, and conclusions drawn, all by the students themselves under teacher guidance.

Analyzing the students' procedures according to the list of "Elements of the Scientific Method" in *Everyday Science* [1] which is nearly synonymous with Keeslar's list [2], it is found that they coincide on the following points:

1. They located and defined their problem—the effects of continual burning.
2. They planned the study.
3. They used a control—the unburned area.
4. They isolated the experimental factor—burning.
5. They made careful observations (within the limits of individual differences).
6. They drew inferences and conclusions after observing the facts at first hand (at the level of their ability).
7. They made hypotheses—as to the consequences to plant, animal, and finally to human life and welfare, of the practice of habitual burning.

The control group, meanwhile, studied the unit on Conservation in the text *Everyday Science* by Caldwell and Curtis, supplemented by additional reading in a series of pamphlets on Conservation and a number of articles in current magazines. They also studied a chart on the effects of soil erosion. There was also the usual daily laboratory work which in this case consisted of individual microscopic study of samples of various types of soil, paying particular attention to texture and moisture holding content. They also had the opportunity of examining a number of insect specimens common to local soils.

V. ANALYSIS OF THE EXPERIMENT

Table I shows the results of the analysis of the experiment. Complete figures are given for Final scores only.

a. The Initial Scores and Final Scores on the Scientific Attitudes tests, and the I.Q. scores from the Otis Mental Achieve-

TABLE I

RESULTS OF SCORES IN FINAL SCIENTIFIC ATTITUDES TEST OF PAIRS MATCHED ON INITIAL SCIENTIFIC ATTITUDES TEST

Pair	I.Q. Scores		Initial Scores		Final Scores		Difference		Dif.²
No.	X	C	X	C	X	C	+	−	
I	116	109	36	36	40	23	17		289
II	129	109	39	39	38	27	11		121
III	111	120	33	33	37	32	5		25
IV	130	115	33	32	40	23	17		289
V	112	104	33	31	40	23	17		289
VI	116	96	30	30	31	30	1		1
VII	115	110	30	30	29	21	8		64
VIII	99	104	30	30	39	25	14		196
IX	98	99	30	30	34	26	8		64
X	111	98	29	30	33	29	4		16
XI	107	75	29	29	31	30	1		1
XII	120	128	29	29	37	34	3		9
XIII	105	114	28	28	35	35	0		0
XIV	106	107	28	26	39	35	4		16
XV	88	109	27	27	27	27	0		0
XVI	97	100	27	26	28	25	3		9
XVII	99	118	27.	26	15	32		17	289
XVIII	107	95	26	26	30	18	12		144
XIX	115	94	25	25	24	26		2	4
XX	99	94	24	24	30	23	7		49
XXI	91	101	23	23	27	19	8		64
XXII	95	111	23	24	33	21	12		144
XXIII	102	98	22	22	22	28		6	36
XXIV	110	101	21	21	29	17	12		144
XXV	116	73	20	20	24	17	7		49
XXVI	80	103	19	20	24	8	16		256
XXVII	95	89	19	20	22	15	7		49
XXVIII	95	92	19	19	28	20	8		64
XXIX	98	96	18	18	18	22		4	16
XXX	89	104	17	17	21	21	0		0
Total	3151	3066	794	791	905	732	202	−29	2697
					173		173		

X=Experimental Group.
C=Control Group.
$I.Q._{\bar{x}}=105.03$.
$I.Q._{\bar{c}}=102.2$.
$S.d.(X)=11.69$.
$S.d.(C)=11.74$.
$t_o=.3182$. $t_{.05}=2.045$.
$t_o \sim P>.05$.
∴ No significant difference.

Initial Scores
$\bar{x}=26.47$.
$\bar{c}=26.37$.
$S.d.(X)=5.49$.
$S.d.(C)=5.29$.
$t_o=.7692$. $t_{.01}=2.756$.
$t_o \sim P>.05$.
∴ No significant difference.

Final scores

$$\bar{x}=\frac{905}{30}=30.17.$$

$$\bar{c}=\frac{732}{30}=24.4.$$

$$\bar{D}=\frac{173}{30}=5.77.$$

$$S^2_D=\frac{N\Sigma D^2-(\Sigma D)^2}{n(n-1)}=\frac{30(2697)-(173)^2}{30(29)}.$$

$$\frac{80'910-29'929}{870}=58.599.$$

$$S_{\bar{D}}^2=\frac{58.599}{30}=1.953.$$

$$S_{\bar{D}}=\sqrt{1.953}=1.397.$$

$$t_o=\frac{5.77}{1.397}=4.1302.$$

$t_{.01}=2.756$.
$t_o \sim P<.01$.
∴ There is a significant difference.

ment tests were used as the basis for the statistical analysis of the experiment.

b. Treated as ungrouped data, the means and standard deviations of these scores were computed.

c. The thirty-four members of the

Experimental and Control groups were matched on the basis of their scores in the Initial Scientific Attitudes test. Only four pairs were lost in the matching, making a total of thirty matched pairs whose scores were used in the analysis.

d. The Final Scores of the matched pairs of the Experimental and Control groups were checked against the *t* model to test whether the ratio of their mean difference to its standard error was distributed as *t* in repeated sampling. In other words, we tested the Null Hypothesis that there was no difference in the two methods of instruction as to the outcomes measured. If the outcomes were the same, the Experimental and Control groups might be considered as random samples from the same model.

However, it was found that $t_o = 4.1320$ as compared with $t_{.01} = 2.756$. Therefore the Null Hypothesis was in this case rejected at the 1 per cent level and the conclusion was reached that, under certain assumptions, the two methods of instruction produced significantly different results.

Correlations were made between the Experimental and Control groups and tested for significance. There was found to be no significant difference in intelligence between the Experimental and Control groups as expressed by their I.Q. scores. Therefore the difference, which was significant, between the Initial scores and the Final scores of the Experimental group as compared with the Initial and Final scores for the Control group must be attributable to some other factor than a difference in intelligence. This factor, as has been indicated, was the difference in the two methods of instruction.

It was found that there was a significant difference between the mean scores of boys and girls in the Experimental group at the 2 per cent level, the girls' scores being somewhat higher. There was found to be no significant difference between the scores of boys and girls in the Control group.

VI. OUTCOMES

1. The new information which the students acquired from their study of the burned and unburned areas may be seen from observation of the following Tables II–IV. The great differences which they found in biological and soil content of the two areas are clearly shown in these student findings.

TABLE II

LIST OF LIVING THINGS FOUND IN FIVE FOUR FOOT SQUARE PLOTS IN UNBURNED AREA

Plant Life	Animal Life
1. Bloodroot	1. Angleworms
2. Common dandelion	2. Bumble bee
3. Spring beauty	3. Ants, eggs and larvae
4. White snakeroot	4. Mosquitoes
5. Mosses, 4 or 5 kinds	5. Wood tick
6. Woodland grasses, 3 kinds	6. Gnats
7. Wood anemone	7. Inch worm
8. Wild columbine	8. June bug pupa
9. Bush honeysuckle	9. Spiders
10. Yellow puccoon	10. Grub-worms
11. Oxalis (wood sorrel)	11. Mole
12. Wild blackberry	12. Ruffed grouse
13. Cranesbill	13. Wood thrush
14. Bellwort	
15. Wild ginger	
16. Mushrooms, 3 types	
17. Jack-in-the-pulpit	
18. Wood horse tail	
19. Trillium	
20. Golden aster	
21. Meadow rue	

Plant Life—Continued

22. Giant false Solomon's seal
23. Dwarf false Solomon's seal
24. True Solomon's seal
25. Woodbine
26. Sumac
27. Gold thread
28. Wood ferns—3 kinds
29. Brake
30. Poison ivy
31. Elderberry
32. Strawberry
33. Elm seedlings
34. Oak seedlings
35. Gooseberry, wild
36. Box elder
37. Red oak
38. Wild cherry
39. Wild black currant
40. Frost grade

TABLE III

LIST OF LIVING THINGS FOUND IN FIVE-FOUR FOOT SQUARE PLOTS IN BURNED OVER AREA

Plant Life	Animal Life
1. Quack grass	1. Ants
2. Mullein	2. Sow bug
3. Asparagus	3. Inch worm
4. Red clover	4. Angleworm
5. Frost grape	
6. Willow (burned)	
7. Pine seedlings (burned)	
8. Elm seedlings (burned)	
9. Plantain	

TABLE IV

SUMMARY OF STUDENTS' FINDINGS FROM THE FIELD TRIP STUDY

1. Average number of specimens found in each four foot square plot.
   a. Unburned plots
      Plant life—26 Animal life—9
   b. Burned plots
      Plant life—7 Animal life—3
2. Soil samples
   Unburned plots
      Sub-soil—light brown sand.
      Top soil—dark humus to depth of 3–6 inches, moist surface covered with layer of dead leaves, crumbly leaf mold, moist, filled with network of fine, hair-like rootlets.
   Burned plots
      Sub-soil—light brown sand
      Top soil—light brown sand, coarse, dry, few roots, those coarse, largely quack grass.
3. The burned area had had an attempt at reforestation made upon it. This year's burning (about three weeks previous to the study) had, however, scorched all of the newly planted seedling trees, as well as the sparse natural vegetation.

   There were no eggs, larvae or pupae of insects found in this area, compared to several kinds found in the unburned area.
4. Student's remarks—quotations.

   "Burning is undesirable. It destroys the fertility of soil and the natural 'habitations' of insects and birds."

   "Burning does not pay. It kills plants and animals; some come back, but most of them do not."

They found a very great difference in the top soils of the burned and unburned areas. The former was coarse and dry and contained coarse and sparse roots; the latter was deep moist leaf mold filled with a network of fine rootlets. The burned area showed signs of incipient erosion; in the unburned area the soil was protected by the layer of leaf mold and the network of fine rootlets.

The difference in the fauna was marked, that of the flora even more so, both in quantity and quality of plant and animal life present.

2. By assuming the responsibility for planning and carrying out these excursions, making observations and drawing conclusions from the data which they had obtained, the students gained practice in a functional application of the scientific method.

3. From the functional use of the scientific method the students gained an increase in scientific attitudes which is shown by the statistical analysis to have been of significant value.

VII. SUMMARY

1. A significant difference was found in the Final scores on Scientific Attitudes between the members of the Experimental group who had experienced field trips and the members of the Control group who had experienced regular classroom procedures on comparable material under the same teacher.

2. These differences were shown to not be attributable to differences in intelligence nor to differences in initial scores of the

two groups, and only in the Experimental group was there shown a sex difference. Therefore the hypothesis may be formulated that these differences are due to some other factor, such as interest or motivation aroused by their field trip experiences.

3. Considering these groups as random samples from the population of the Junior High School of Stillwater, Minnesota, we may draw the conclusion that, on the whole, a ninth grade general science class which experiences field trips, shows a greater development of scientific attitudes than a class of equal ability, as shown by I.Q.'s and pre-tests, which does not go on field trips, but which experiences regular classroom procedures of teaching comparable material by the same teacher.

4. It was demonstrated that it is practicable for a class of ninth grade general science students to apply the scientific method in studying a phase of their environment, thereby gaining functional understanding of their problem.

5. The class added a fund of new information to their knowledge of the local plant and animal life and soil conditions, and made a real contribution to a local problem in their study of the effects of continual burning over of nearby areas. The difference found in the effects upon the local flora, fauna, and soil content, was sufficiently marked to impress the least observant.

6. It was demonstrated that a fifty-five minute class period was adequate time in which to go on a worth-while excursion to points several miles distant from the school, provided adequate preparations were made in advance and cooperation was shown by everyone concerned.

VIII. EDUCATIONAL IMPLICATIONS

Within the limits of this study, the results show an encouraging difference achieved by the two teaching methods. Here student planning and carrying through of a problem solving situation by means of a functional application of the scientific method seems to have resulted in a significant increase in scientific attitudes. Motivation arising from interest aroused by first hand experiences in the field seems to have been significantly greater than that gained from vicarious study in the classroom. Judging from the results of this study the extra effort expended upon providing worth-while field trips seems to be well worth-while as judged by the results measured.

Nearly every school has within walking or riding distance a vacant lot, bit of park, or roadside area which may offer a fruitful source of study for some project in biology or general science. In addition, other excellent opportunities for school excursions are offered by local museums, manufacturing plants, water works, dairies, sewage disposal plants and the like. A school excursion to any of these, if efficiently planned and designed for the purpose, may supply the necessary incentive for attaining the additional impetus toward the desired goals of good science teaching.

Given careful teacher-pupil planning, cooperation from the school authorities and the community, there seems to be little excuse for not affording science classes the opportunity to increase their understanding and appreciation of their environment which comes from firsthand study outside of as well as within the schoolroom.

BIBLIOGRAPHY

1. Caldwell, Otis W., and Curtis, Francis D. *Everyday Science.* Ginn and Co., Boston, Mass., 1946. Pp. 610, 611.

2. Keeslar, Oreon. "The Elements of the Scientific Method." *Science Education,* 29:273–278, December, 1945.

3. Curtis, Francis D. *Tests to Accompany Caldwell and Curtis's Everyday Science.* Tests on Scientific Attitudes. Test on Scientific Method.

4. Johnson, Palmer O. *Statistical Methods in Research.* New York: Prentice-Hall, Inc., 1949. Pp. 75–80.

PANDORA'S PANACEA

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PANDORA'S Panacea is a very convenient device. It is one of the most useful pieces of apparatus in a modern classroom where mechanization is extensively employed.

An examination of the photograph will reveal that the device is basically a box (Pandora) that seems to solve many problems (Panacea). The device is easily designed and built. It is a rectangular box of wood or metal with a removable cover and one end slanted at a forty-five degree angle. The inside of the box is painted with aluminum paint and equipped with a twenty-five watt electric bulb. To accommodate the slides, a shelf base is placed on the slant end with elastic bands and a hinged adaptor for smaller slides. Immediately behind the slide the bottom is painted white. On the side of the box, a holder and magnifier reading glass are easily available for the operator.

Originally the device was intended for the teacher's use as a preview scanner for preparing a set of slides. It has been very useful in this respect for previewing "Kodachrome" and "Lantern" slides.

Other uses, which make the device even more valuable, have been discovered. Many times the author has hesitated to blacken the classroom to show a group of three or four slides, because of the loss in time and break in continuity involved in making these physical changes in a classroom. As a result, many small groups of slides were not shown. Pandora's Panacea has filled a need in this situation. A slide can be mounted, secured with rubber bands and the whole passed about the room. At his desk the student can connect the cord to his desk power outlet and carefully study the slide making use of the magnifying glass to get greater detail. This use might be termed "Individual Audio-Visual Aids."

A third and important use of the device is its use to accompany a large collection of slides for either a retarded or an advanced student. He examines illustrative slide material correlated with a text or syllabus. Studying this material, the student can advance more rapidly than the class as a whole, to solve his individual problems.

An additional use has been discovered by the students. In an effort to develop better laboratory drawings, the students placed paper over the lighted glass slide and made a tracing or a drawing of the picture quite rapidly.

It has been found that small living material (particularly plants) can be placed between two plane glass plates secured by rubber bands, and examined through the magnifier when the plates are placed on the viewing stage of Pandora's Panacea. When specimens are examined this way, it is possible to obtain greater detail, clarity and visibility, than can otherwise be secured.

If the slides are removed and a museum jar, with its included specimen is placed in the opening, a remarkably clear view of the

specimen can be obtained, particularly if the magnifier is used.

Pandora's Panacea has many more possible uses where much concentrated light is needed in a small area. The reader can probably add to this list of suggested uses.

FUNDAMENTALS OF SOUND THROUGH VISION

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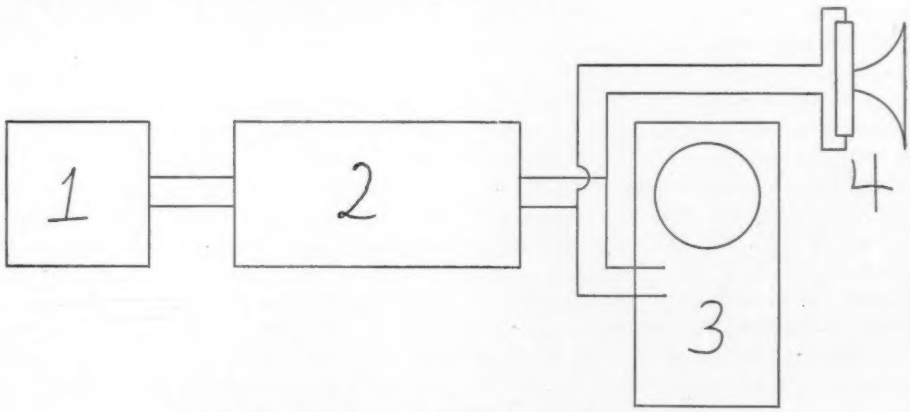
EVEN though this is a very simple experiment and has probably been used by others, several teachers to whom the author has described this demonstration have suggested that it be written describing briefly the apparatus and procedures. This demonstration is well suited for use in the senior high school physics classes and the college general science classes.

The purpose of this demonstration is to correlate the hearing of sound to a picture of the same sound so as to more clearly explain such terms as fundamental, pitch, wave length, intensity, quality, and overtones. This is done by producing a sound by voice, musical instrument, or any other means which is picked up by a microphone, passed through an audio-amplifier and projected on the screen of a cathode-ray oscilloscope. The author also had a few special sound records so an electric phonograph turntable was substituted for the microphone in which case a loudspeaker and the cathode-ray oscilloscope were connected in parallel to the output of the amplified unit.

The simplified drawing will illustrate the hookup:



1. Microphone or phonograph turntable or both.
2. Audio-amplifier.
3. Cathode-ray oscilloscope.
4. Loudspeaker; may or may not be used.

Of the above items probably the only one not commonly found in the average good high school would be the oscilloscope. However the author feels that an inexpensive 'scope is as important as many other items purchased at comparative cost. It has a wide range of uses. If an audio-amplifier is not available this is a worth while and interesting construction project for any small group interested in electricity.

The author set the 'scope to produce the sine wave of a given length when the standard pitch A tone bar was used. Then the controls for amplitude and wave length were kept constant. The apparatus was set up near the beginning of the unit on sound and was used as an aid to develop the fundamentals of this unit.

The first demonstration was the fundamental from the tone bar, the relationship of amplitude to intensity of sound and the effect of varying the distance of the sound source from the microphone on intensity. This was followed by demonstrating the relationship between pitch and wave length by the use of various tuning forks as C and C′, and the phenomena of beats.

The above was usually followed by using various parts of a tone record ranging from about 20,000 cycles to low frequency.

Other phenomena observed were the overtone patterns of notes on different musical instruments, the picture produced by different persons sounding the same consonant or vowel, noise, and the picture effect of the introduction of the Coronation March played first with full orchestra then with only parts of the orchestra. The latter was from a regular sound study phonograph record.

Probably the sound patterns related to quality created the greatest interest. These were done by two methods: (1) Different students pronouncing the same vowel or consonant, and (2) Students of band and orchestra playing certain notes that were projected on the oscilloscope screen.

In the first activity the students were quite interested in noting that different voices produced entirely different patterns when pronouncing the same letter as "a - - - - - - - - ah," which of course is the reason that a person may be recognized by his voice, i.e., quality. For the second activity the students had looked up and brought tone pictures of various instruments to class. These were compared to tone pictures produced by a student using the same instrument. Also rather striking was the fact that a slight waver of tone on a wind instrument produced a very noticeable effect on the tone picture.

The author used this set up for several years while in high school work and felt that the project was very worth while. As to its ability to create interest there was no doubt. The physics class met during the last period before noon and usually half the class would have to be "shooed out" so they and the author could get lunch before the cafeteria closed.

SELECTION AND TRAINING OF FUTURE SCIENTISTS
II. ORIGIN OF SCIENCE INTERESTS

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In an earlier paper [1] a plan was set forth wherein young people on the high school level were given the opportunity to develop their interests in science.

Since 1945, careful observations have been made by the writer of the behavior of certain students who can be said to have shown a "science potential" as indicated by the caliber of their work (participating in intensive study beyond the high school level as well as in small research activities which test originality). Since 1945 some 323 students have availed themselves of the opportunities for special "project" work in science [1] offered at the Forest Hills High School, New York. Some 52 of these students have been judged to have "research potential." Whether or not this judgment is valid depends on the future output of these students in science. Preliminary data gathered from a study of the 52 in college and graduate school indicate that our judgments have considerable validity.

Since 1945, when the first group of students trained in the program described in [1] were graduated, 13 of these 52 students have been Finalists and 21 have been awarded Honorable Mention in the Westinghouse National Science Talent Search. (Thirty-four "winners" in approximately five years, appears to be beyond the ex-

pected success for a school which accepts a heterogeneous group of students who are not selected for their science interest.)

Each one of the 52 has won some honor in Science on the high school level; so have a good number of the other 271. Furthermore 9 of the 52 have already been graduated from college, 7 have been accepted in research, 2 (females) have taken up the duties of housewives; of the remaining 43, 39 have maintained a very high caliber of work in science. Steps are under way to follow up the other (271) students, as well as students who have shown no intensive science interest in high school.

Preliminary indications, as far as the Westinghouse Science Talent Search is concerned, are that the 34 "winners" (finalists and Honorable Mention) of the 52 have yielded no more individuals to scientific research than the 21 who did not "win." However, all 52 entered the Westinghouse examinations which are intended to ferret out individuals with high science ability or "science talent."

The writer's hypothesis is that there is no such quantity as "science talent" but that very high intelligence [2] (as measured by high I.Q., high mathematical ability, high verbal ability) coupled with an environment favorable to interesting work in science, may produce the individual who is successful in scientific research. In any event, there doesn't appear to be any evidence at hand to deny the validity of this hypothesis, although there have been a number of notes and papers dealing with it. [3, 4, 5, 6, 7, 8]

Preliminary work on the origin of the science interests of these youngsters tends to support this hypothesis. When one works with boys and girls in class, in clubs, in laboratories, on field trips, in the many informal relationships (including "just talking") which are the boon of teaching, one learns a good deal about them that one cannot learn by questionnaires, although this device, as well as the autobiography, were used early in this study. It is easy to steer a conversation into previous interests, out-of-school activities, and future goals.

It is quite clear from a study of the 52 students mentioned that theirs was a variety of interests as far back as their memories go. Only 24 of the 52 indicated that their interests in science went back before the age of 14. Ten had no recollection that their science interests were more important to them than other interests; 18 indicated that a major interest in science had been really awakened by the opportunities in high school. Furthermore only 29 of the 52 indicated that they were interested in science enough to think of it as their major choice in their second year in high school. The others were not at all certain. There is also good indication that for many of these students prior to the age of 14, such activities as sports, music, general reading, art were of equal or of greater interest.

But as they began to select vocational interests, the opportunities available for exploration of these interests and their success (honors, etc.) played a great part in choosing their interest of greatest concentration—in this case, science. As a result, after the second year in high school, all 52 spent more than one-third of their free time out of high school (a rough average of 10 hours per week) in science activities.

Early in this study, it became clear that many students in the first year of General Science at Forest Hills had spent more than 8 hours per week in science interests (chemical sets, radio, model airplanes, etc.) prior to the age of 13–14, yet did not sustain their interest. For instance, of several freshman groups comprising 163 students, 37 students (33 boys, 4 girls) in answer to a questionnaire, indicated such a major interest in science. Their parents confirmed this interest, as did interviews with the students to check their statements. Yet of these 37, only 16 sustained their interest throughout high school in a major way. The other 21 turned to different fields. It may be that further study will lend support to the writer's present concep-

tion of the situation, namely, that in our present society, youngsters before 14, are interested in science much as they are interested in sports, or music, or reading, or collecting stamps. Then as they get into high school and college, their teachers, the opportunities for prosecution of scientific work, and their success in science, determine, at least in part, who will go into science. Zim's study adds further evidence along these and other lines [9].

Furthermore, each one of these students was clear in his notion that some adult had kindled and maintained his interest in science; 14 of the 52 students named parents, relatives or friends, 38 named teachers in elementary and high school. This is clear not only from talks with these students and parents, but from questionnaires and biographies as well.

From a preliminary study it is also clear that certain teachers are much more successful in kindling science interest than are others. The students in this study were consistent in mentioning the same teachers time and time again.

This preliminary study of original science interest indicates that, given proper opportunities [1] and specially trained teachers, the high school can stimulate and sustain the science interests of qualified students. There is no indication at the present state of the investigation that there is a special "science talent" *per se*. There is every indication that young people with "science potential" can be recognized early in their high school careers. This will be the subject of an early report.

Four *patent factors* seem to affect the origin of an interest in science in students with "science potential," (1) high intelligence of the type which results in high success on tests of intelligence and of mathematical and verbal skills, (2) well trained teachers, (3) the opportunities for work in science, (4) success in science, over and above success in other intellectual or artistic endeavors. A *latent factor* which seems to be present is a science interest early in youth. But this latent factor may not be indicative *per se* of "science potential," since it is not sustained in a good number of students. Whether there is another latent factor to be called "science talent" remains to be determined and defined by continued investigation as do, indeed, the preliminary and tentative summarizations made here.

However, there is no doubt that future scientists are influenced or can be influenced by the opportunities made available to them in their early pre-college education. This has significance for those national programs which recognize our continued need for scientists.

BIBLIOGRAPHY

1. Brandwein, Paul F. *Scientific Monthly*, Vol. LXIV, 1947, pp. 247–252.
2. Edgerton, H. A., and Britt, S. H. *Occupations*, Dec., 1943, pp. 177–180.
3. Edgerton, H. A., and Britt, S. H. *American Scientist*, 31, 1943, 255–262.
4. Hoffman, Banesh. *American Scientist*, 31, 1943, 255, 262.
5. Edgerton, H. A., and Britt, S. H. *American Scientist*, 31, 1943, 263–265.
6. Brandwein, Paul F. *Science Education*, 28, 1944, 47–49.
7. Edgerton, H. A., Britt, S. H., and Davis, H. M. *Science Education*, 28, 1944, 229.
8. Brandwein, Paul F. *Science*, 1945, 101–117.
9. Zim, Herbert S. *Ethical Culture Schools*. New York, 1940.

A LABORATORY DEMONSTRATION STROBOSCOPE

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INTRODUCTION

LABORATORY demonstrations of rotating and reciprocating mechanical devices are greatly enhanced when the operation of the device can be apparently slowed, stopped, or reversed by use of a stroboscopic illuminator.

Unfortunately, commercial-grade stroboscopes, such as those made for engineering investigations by the General Radio Com-

pany, are too costly and complicated for use in any but the largest and best-endowed schools. Small stroboscopes, for laboratory and classroom use, seldom appear on the market, and most of them are too inflexible for effective instructional use.

GENERAL PRINCIPLES

When a body rotating at a uniform rate, and having upon it an index mark, such as a radius line, is viewed under intermittent illumination, the body will appear to stand still when the number of flashes per time interval equals the number of rotations in the same time. If the number of flashes per time interval exceeds the number of revolutions, the body will appear to rotate backward; and if the flashing rate is less than the rotation rate, the body will apparently rotate forward.

If, under the same conditions, the number of flashes is an even multiple of the number of revolutions, the index mark will appear to be multiplied by the same factor. Similar apparent changes can be produced in the motion of a reciprocating body, such as a connecting rod.

TYPES OF STROBOSCOPES

More than a generation ago, intermittent lighting for the study of moving bodies was obtained from various types of spark gaps, timing being accomplished by mechanical coupling with the device under investigation, or with a standard of speed.

More recently, gas-discharge tubes, driven by an oscillator, have been used. Where illumination requirements are not great, a 3-watt neon lamp, in series with a half wave rectifier, becomes a satisfactory one-flash-per-cycle stroboscope [1] when connected to the A. C. line.

Within the last fifteen years, as a result of researches by Germeshausen and Edgerton, a new type of gas-discharge tube, now known as the *strobotron,* has been developed, and is now in commercial production. This is a neon-filled tube, in which a high current electrical discharge between two electrodes is initiated by a low current discharge between one of them and a control electrode.[2]

Such a tube can be controlled by a small master oscillator, or it may be made self-cycling by connecting the cathode and one of the control grids as a resistance-capacitance oscillator.[3] Because a self-cycled strobotron tends to lack flexibility unless special components are inserted to reduce circuit interaction, one driven by a master oscillator is preferable for most classroom and laboratory uses.

CIRCUIT CONSIDERATIONS

Electrical circuit of a small stroboscope, consisting of a power supply, a master oscillator, an amplifier, and the output tube (a strobotron), is shown in Fig. 1. This circuit was chosen, in preference to at least a dozen others which will perform the same functions, because it gives the maximum performance per dollar of cost, and uses only standard radio components, available over the counter in large cities, and by mail from regular suppliers.

POWER SUPPLY

The power supply for this stroboscope is a straightforward voltage-doubling "transformerless" rectifier, using the standard full-wave voltage-doubling circuit. Rectifier is a 50Y6-GT tube; condensers are 100 MF. 150-volt dry electrolytics. Charges on the two condensers (C_1 and C_2) are replenished through the rectifier on

[1] Coleman, J. E. *Clockwise and Otherwise,* Amer. Horologist and Jeweler, Vol. 15, #8, August, 1949, p. 89.
Germeshausen, E. J., and Edgerton, H. E. *The Strobotron,* Electronics, Feb. 1937, p. 12.
Marcus, John, and Zeluff, Vin. *Handbook of Industrial Electronic Circuits,* New York, 1948, p. 215.
Ives, R. L. *Horological Stroboscopes,* Electronics, March, 1950.

[2] Full operating and installation data concerning various strobotrons can be found in Sylvania data sheets for the SN4, 1D21, and R4350 strobotrons, available from Sylvania Electric Products Co., Emporium, Pa., and in Edgerton, Germeshausen, and Grier patents 2,195,189 and 2,201,-167.

[3] Cruft Electronics Staff, *Electronic Circuits and Tubes,* New York, 1947, pp. 521–525; 783–788.

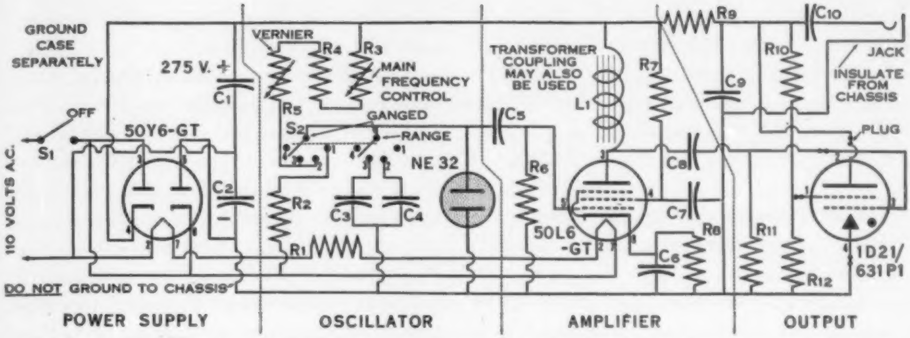

FIGURE 1. Circuit of a small laboratory stroboscope, designed for operation from any 110 volt alternating current supply.

alternate half cycles of the supply current, and power drain is from the two condensers in series.

Filaments of both tubes, the 50Y6 and the 50L6, are connected in series with R_1 (about 100 ohms) across the line. All power is controlled by S_1, a standard toggle switch.

MASTER OSCILLATOR

The master oscillator, which, through the amplifier, controls the flashing rate of the strobotron output tube, is a small neon oscillator. Multiple frequency ranges are provided, to facilitate demonstrations, and ranges are selected by various positions of S_2.

The neon bulb can be any standard low-wattage neon lamp, but it must be able to discharge the largest condenser in circuit in a short time. A type NE-32 bulb, having considerable mechanical ruggedness, was chosen for this position.

In operation, a condenser (C_3 or C_4) is charged from the power supply through a high resistance, usually several megohms. When the voltage across the condenser reaches the striking voltage of the tube (about 75 volts), a glow discharge takes place, and continues until the voltage across the condenser falls to the extinction voltage of the tube (about 60 volts). The condenser then recharges to the striking voltage, and repeats the cycle indefinitely.

The main frequency control in this circuit (R_3) is a 0–10 megohm volume control resistor. In series with this is a 250,000 ohm variable resistor used as a vernier (R_5) and a 1 megohm fixed resistor (R_4) inserted in circuit to prevent burning out the neon bulb should both main and vernier frequency controls be set at a very low value.

To permit one-flash-per-cycle operation, position 1 of S_2 is connected to the rectifier mid point, so that, with this connection, the neon bulb "fires" once on each positive half cycle.

Overlapping frequency ranges from about 10 to about 800 cycles per second can be secured by evaluating C_3 and C_4 at .06 and .006 MF. respectively. A very low frequency range, from 0.5 to about 12 cycles per second was installed at position 4 of S_2 by use of a 2 MF. condenser. Frequency formulas are not very helpful in finding the correct values here, for commercial condensers in the low price range not only deviate considerably from their rated capacity, but are not pure capacitance. However, if condensers of good manufacture are used, their characteristics will change little with age and use.

AMPLIFIER

The amplifier unit, which makes the voltage fluctuations in the oscillator circuit large enough to trigger the strobotron, is an entirely conventional pentode amplifier, using a 50L6-GT tube. Grid circuit is coupled to the oscillator through C_5 (.001 MF, value not critical) and grid bias

reaches the grid through a resistance of about 1 megohm (R_6). Cathode is biased plus with respect to the grid by the voltage drop across R_8, which is about 500 ohms, and A. F. is bypassed around the resistor by C_6, evaluated at .05 MF. or more. Screen voltage is reduced to desired operating value by R_7, about 0.1 megohms, and screen bypass is C_7, 0.06 MF. or more.

Voltage fluctuations at the plate of the amplifier are directed to the control grid circuit of the strobotron by use of a plate choke between the tube plate and power supply. This is L_1 in Fig. 1, and is 30 or more henries. Output coupling condenser, C_8, is .005 MF. approximately.

STROBOTRON CIRCUIT

The strobotron circuit is conventional, except for the sound tap, consisting of a 0.1 MF. condenser (C_{10}) and a jack. This permits monitoring the amplified oscillations, and coupling of the oscillator output to other output devices.

Illumination from the strobotron is obtained from the sudden discharge of C_9 (4 MF.) through the tube, in response to a trigger impulse received on the control grid (3). Recharge of this condenser takes place in about 1/250th second through a resistance of not less than 3500 ohms (R_9).

During intervals of no signal, the inner control grid of the strobotron is held at ground potential by means of a resistance to ground (R_{11}, 1 megohm). The outer control grid of the strobotron (1) is held about 25 volts above cathode potential by means of a voltage divider consisting of R_{10} (100,000 ohms) and R_{12} (10,000 ohms).

When the grid of the amplifier, in response to an oscillator "kick," goes negative suddenly, the grid of the strobotron (3) is driven positive by an equal amount,

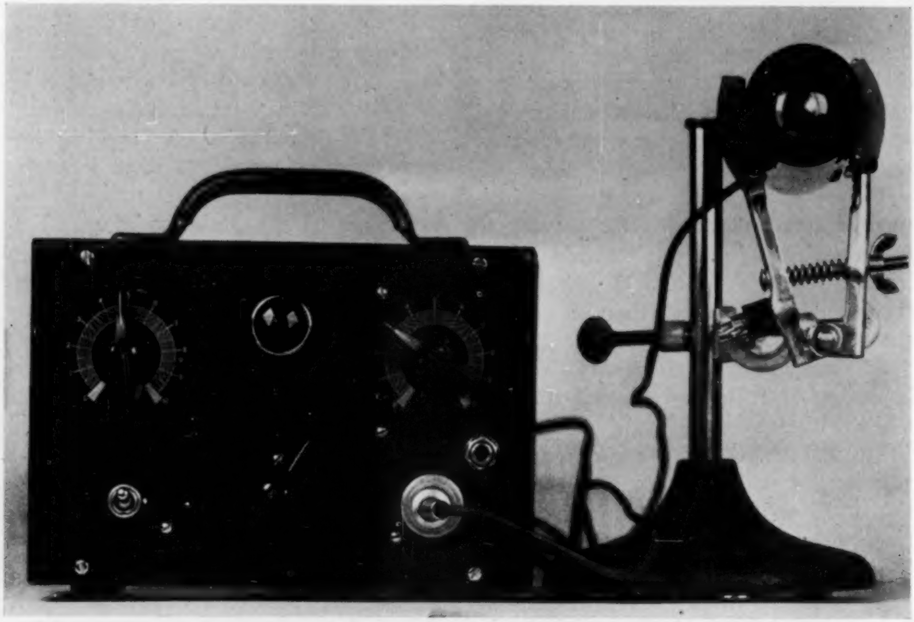

FIGURE 2. Complete stroboscope built into a standard 5" by 6" by 9" radio cabinet. Controls and connections, from left to right, are: top—main frequency control, neon oscillator bezel, range switch; bottom—off-on switch, vernier frequency control, strobotron plug; sound output jack is at extreme right above strobotron plug. Note carrying handle and rubber feet on case.

because of the phase reversal across the amplifier (50L6). Glow discharge takes place in the strobotron from the control grid to the cathode (3 to 4), as that is the path of greatest potential difference. Once this glow discharge takes place, the neon content of the tube is ionized, and arc discharge commences from the plate (2) to the cathode until the charge on C_9 is dissipated. Because this discharge consists of about .001 coulumbs in less than 1/250th second, this produces an intense flash of light.

CONSTRUCTIONAL FEATURES

General Statement

Construction of a stroboscope of this type is not at all difficult, and can be done by almost anyone able to read a wiring diagram and solder a connection. Arrangement of components is not critical; numerous alternative arrangements and connections are possible; design changes that will work "on paper," in general, will also work in practice.

Volume of standard components necessary for a stroboscope of this type is approximately 78 cubic inches, exclusive of the strobotron and its socket. Some space must be allowed for connections, and some air channels are necessary to cool the tubes and resistors.

To accommodate the requisite controls, about 40 square inches of panel space is desirable. In consideration of these space needs, it is apparent that a stroboscope of this type can be built to fit into a standard 5″ by 6″ by 9″ radio case without encountering "packing factor" difficulties or cooling problems. General appearance of such an instrument is shown in Fig. 2.

MECHANICAL FEATURES

Assembly and mounting of components was facilitated by use of a prepunched chassis base, which is attached to the panel by two ⅞″ brass spacers. Condensers for power supply and tubes are mounted in the four socket holes. Power supply components were mounted under the chassis;

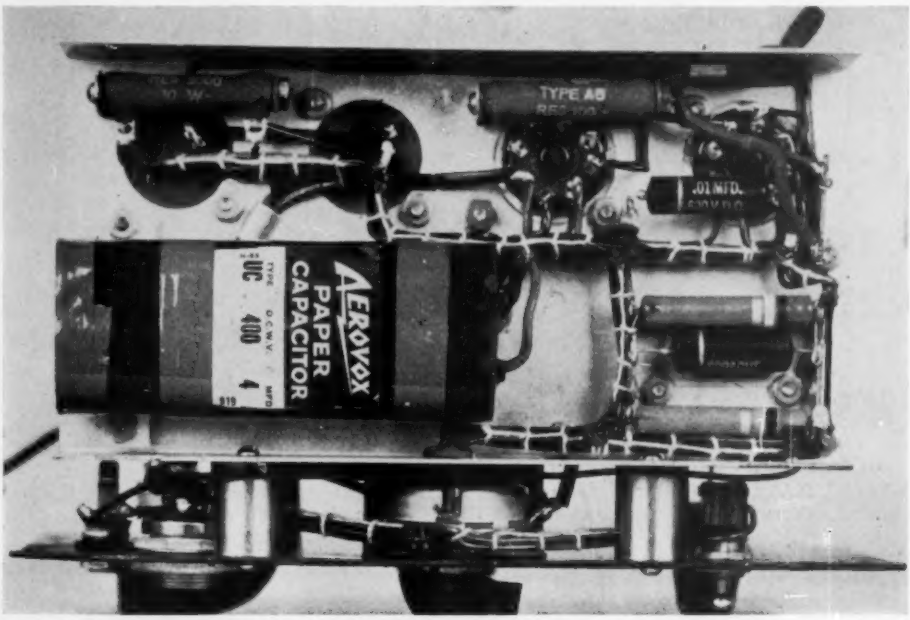

FIGURE 3. Under-chassis view of stroboscope. Large condenser at right stores energy for strobotron flashes. All wiring is cabled, and major components are firmly anchored in place.

frequency control components above it. The NE-32 tube, used as an oscillator component, was mounted on a bracket behind a panel bezel, so that it not only doubles as a pilot light, but can also be observed in operation.

Small components are mounted on tie strips, to facilitate servicing and eliminate most wire splices, as in Fig. 3, a view of the under-chassis parts of the stroboscope. Wiring is cabled, to eliminate the "rat's nest" appearance so common in electronic equipment.

Above-chassis arrangement is fairly standard, and not at all critical except that condensers and resistors must be kept as far as possible from tubes, to prevent heating, with resultant thermal drift of frequency and shortened service life. General arrangement of above-chassis components, all concerned with frequency control and output, is shown in Fig. 4.

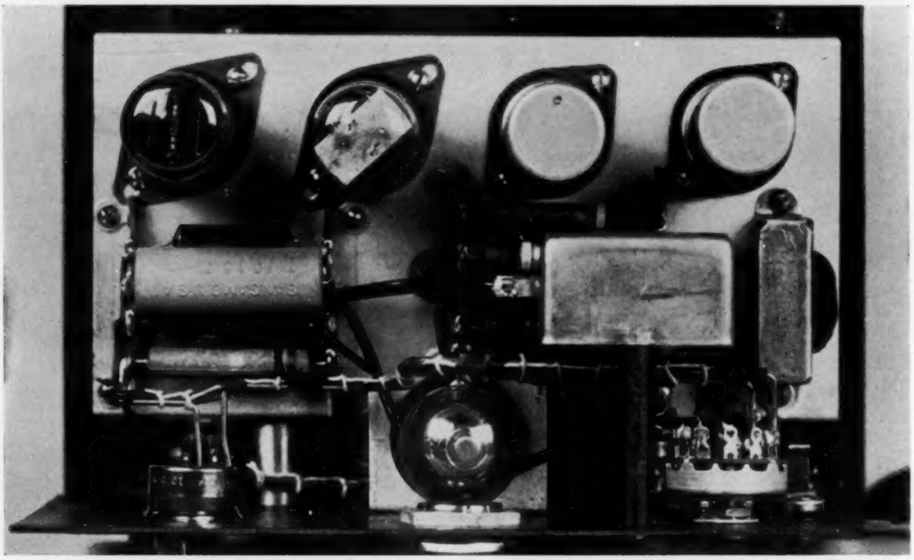

FIGURE 4. Above-chassis arrangement of components. Parts at rear, from left to right, are: 50Y6-GT, 50L6-GT, C_1 and C_2. Across center are resistors and condensers of oscillator and output circuits, with amplifier plate choke at extreme right. Visible close to panel are, from left to right, main frequency control, neon oscillator bulb, and range switch.

To keep operating temperatures within the thermal tolerance of the components, a 1½" hole is drilled in the bottom of the case, and covered with screen wire, and a similar hole 3" in diameter, also screened, is drilled in the back. Convection through these openings keeps interior temperatures below about 140° F. Without such ventilation, interior temperatures run above 200° F., causing rapid failure of the power supply condensers.

Mounting of the strobotron tube in its socket can be arranged to suit the user's taste. A convenient mounting is a piece of fiber tubing, with the socket supported inside by angle brackets. Connection to the instrument case is by means of a four wire cable and plug.

COSTS AND CHOICE OF COMPONENTS

Standard components for the construction of a stroboscope of this general design cost about $30.00 at retail. Considerable saving in first cost is possible if "war surplus" components are used, but replacement of many surplus parts will not be possible indefinitely, causing an increase in maintenance cost which may more than offset the original saving.

In general, standard parts made by reputable manufacturers will outlast their rated life by a factor of at least 1.5. A saving of about 20 percent in first cost is possible if substandard parts are used, but their service life is usually short. Many of the very inexpensive "surplus" components now on the market are there because they are no good.

OPERATING DATA

With a stroboscope of this type, it is possible to demonstrate the synchronous operation of a standard electric clock motor very effectively. The motor is illuminated by the strobotron, and when the range switch is placed at the one-flash-per-cycle position, the armature of the clock motor appears to stand still. Introduction of slip, by use of slight finger friction, makes the rotor seem to turn backwards.

Likewise, with the same oscillator setting, the slip of any standard induction motor, such as a fan motor, immediately becomes apparent as backward rotation of the perceived visual image.

In general, when flash frequency is greater than a minimum value of about 25 flashes per second, determined by the observer's persistence of vision, a rotating indexed disc viewed under stroboscopic illumination will appear to stand still when the ratio of flash frequency to speed (expressed in compatible units) is unity or a unit fraction (½, ⅓, ¼, etc.).

When the ratio of the flash frequency to the speed of the disc is a whole number, the index mark on the disc will appear to be multiplied by that number. A similar appearance is produced when the frequency-speed ratio is a simple non-unit fraction (2/3, 3/7, 4/11, etc.).

In consequence of the above relations, when a rotating disc with an index mark is viewed by stroboscopic light, there will be a number of frequencies at which the index appears to stand still; and a larger number of frequencies at which the index, although apparently stationary, is duplicated or multiplied. The highest flash frequency at which the index is both apparently stationary and not duplicated is the speed of the disc.

Further extension of these general principles follows the general rules of algebraic permutations and combinations, but is seldom desirable in an ordinary classroom demonstration. Because of the operational simplicity of this stroboscope, each student can try out each step in its operation himself in a very short time, thereby increasing the effectiveness of the demonstration.

SUBJECTS TAUGHT BY HIGH SCHOOL CHEMISTRY TEACHERS, ALABAMA, 1948–1949

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HIGH school teachers usually have to teach more than one subject, and frequently they have to teach in more than one field. This study was made to find out what subjects were taught by the high school chemistry teachers in the white high schools, both public and private, in Alabama during the school year 1948–1949. Some of the schools teach chemistry and physics in alternate years, and 1948–1949 was the year in which chemistry was taught in these schools. The State Department of Education accreditment reports were used as the source of this information.[2] For this study the subjects taught were generally listed individually, except that all mathematics, all social studies and all com-

[1] Present address: U. S. Public Health Service, Virus and Rickettsia Laboratory, Montgomery, Alabama.

[2] The authors wish to thank Dr. M. Morrison McCall, Dr. W. L. Spencer, and Dr. W. L. Davis of the State Department of Education for their assistance.

mercial subjects were grouped together under those headings. This served to simplify the recording of the data although it does to some extent obscure the issue as to exactly what a person taught in some cases.

It was found that 195 teachers taught chemistry, and, of that number, 14 taught no other subject. Not all of these 14 were full-time chemistry teachers, however. Some of them had other duties, as for example, the principal might teach chemistry. Table I shows the number of teachers who taught 1, 2, 3, 4, 5, and 6 subjects, including chemistry. None taught more than six.

TALBE I

ALL HIGH SCHOOLS

No. of Subjects Taught	No. of Teachers	Percentage of Teachers
1	14	7.2
2	36	18.5
3	83	42.6
4	47	24.1
5	12	6.2
6	3	1.5

This shows that while 3 subjects was the most common load, nearly one-third taught 4 or more different subjects.

Table II gives the same information for those teachers, 69 out of the total of 195, who were in schools accredited by the Southern Association of Colleges and Secondary Schools.

TABLE II

SOUTHERN ASSOCIATION HIGH SCHOOLS

No. of Subjects Taught	No. of Teachers	Percentage of Teachers
1	6	8.7
2	22	31.9
3	34	49.3
4	6	8.7
5	0	0
6	1	1.4

In this select group, 3 subjects was again the most common load, but only about one-tenth taught more than 3 subjects.

The 195 chemistry teachers taught a total of 67 different combinations of subjects. In addition to chemistry, they taught biology, general science, physics, mathematics, commercial subjects, English, social studies, home economics, physical education, religion, geography, health, mechanical drawing, music, spelling, industrial arts, agriculture and a few others. However, the situation was not as bad as the list might indicate, because 91 of them taught science only, and an additional 38 taught only science and mathematics. Table III summarizes these and some related data.

These figures show that nearly one half of the teachers taught only science and that two-thirds taught either science only or science and mathematics only. In this Table the number listed as having taught biology includes all who taught that subject in any combination; the same applies to those listed as having taught general science, physics, and mathematics.

Table IV gives comparable figures for those teachers who were in Southern Association schools.

Nearly three-fourths of the teachers in the Southern Association schools taught only science and only 16 per cent taught some subject other than science or mathematics. In the Southern Association schools the chemistry teacher was less likely to teach biology or mathematics and more likely to teach physics than was the case in the whole group. The combinations chemistry, general science; chemistry, physics; and chemistry, general science, physics are found almost exclusively in the Southern Association schools. Of the total of 25 teachers who taught those combinations, 21 were in Southern Association schools, as can be seen from Tables V and VI.

Table V gives some of the more common combinations of subjects with the number and percentage of teachers who taught each combination. This table applies to the whole group of 195 teachers. Table VI gives similar data for the 69 teachers who were in Southern Association schools.

TABLE III

All High Schools

		Percentage of Teachers
Total No. of Teachers	195	
No. of Different Combinations	67	
No. Who Taught Science Only	91	46.7
No. Who Taught Science and Mathematics Only	38	19.5
No. Who Taught Biology	106	54.4
No. Who Taught General Science	97	49.7
No. Who Taught Physics	56	28.7
No. Who Taught Mathematics	55	28.2

TABLE IV

Southern Association High Schools

		Percentage of Teachers
No. of Teachers	69	
No. of Different Combinations	25	
No. Who Taught Science Only	51	73.9
No. Who Taught Science and Mathematics Only	7	10.1
No. Who Taught Biology	28	40.6
No. Who Taught General Science	32	46.4
No. Who Taught Physics	28	40.6
No. Who Taught Mathematics	11	15.9

TABLE V

All High Schools

Subjects Taught	No. of Teachers	Percentage of Teachers
Chemistry	14	7.2
Chemistry, Biology	5	2.6
Chemistry, General Science	10	5.1
Chemistry, Physics	8	4.1
Chemistry, Mathematics	7	3.6
Chemistry, Biology, General Science	23	11.8
Chemistry, Biology, Physics	18	9.2
Chemistry, Biology, Mathematics	6	3.1
Chemistry, General Science, Physics	7	3.6
Chemistry, Physics, Mathematics	8	4.1
Chemistry, Biology, General Science, Physics	5	2.6
Chemistry, Biology, General Science, Mathematics	13	6.7
Chemistry, Biology, General Science, Physical Education	9	4.6

TABLE VI

Southern Association High Schools Only

Subjects Taught	No. of Teachers	Percentage of Teachers
Chemistry	6	8.7
Chemistry, Biology	3	4.3
Chemistry, General Science	7	10.1
Chemistry, Physics	8	11.6
Chemistry, Mathematics	1	1.4
Chemistry, Biology, General Science	12	17.4
Chemistry, Biology, Physics	7	10.1
Chemistry, Biology, Mathematics	1	1.4
Chemistry, General Science, Physics	6	8.7
Chemistry, Physics, Mathematics	3	4.3
Chemistry, Biology, General Science, Physics	1	1.4
Chemistry, Biology, General Science, Mathematics	1	1.4
Chemistry, Biology, General Science, Physical Education	1	1.4

CONSTRUCTION AND EVALUATION OF A NEW GENERAL SCIENCE TEST

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FROM time to time, as educational objectives change, it is desirable to construct and standardize new instruments to evaluate the outcomes of instruction on some wider basis than the local community. We live in a fairly homogeneous nation, and so it is reasonable and sound to appraise our instructional efforts in various subject-matter fields in terms of national performance. This article presents information concerning the construction of a new nationally standardized test in general science, the *Read General Science Test.*[1]

How DO things stand now in the general science field? Is the typical general science student learning the things which the curriculum experts and textbook writers think he should learn? If not, what are the areas where he is failing to do so as well as he should, and what are the areas where he does his best work? Some of the answers may be found in data obtained in connection with the development of this new test.

GENERAL DESIGN OF THE TEST

It was planned to develop a general science test which would be a comprehensive measure, suitable for use at the end of the ninth-grade general science course. It was intended that it should be usable also for final evaluation at the end of a three-year junior high school sequence in general science. Many schools follow either one or the other of these programs, and both single- (ninth) year texts and series of three books are frequently planned so that the same material is covered. It was desired to construct a measure that would reflect current practice insofar as this could be determined, and yet would look forward to the good methods and materials which are emerging as the results of research studies and the work of the yearbook analyses of the needs of American youth in the field of general science.

DEVELOPMENT OF THE TEST

The first problem in the development of this, as of any achievement test, was the determination of the objectives most generally agreed upon for the course, and estimation of the approximate weight to be assigned to these various objectives. As a first step, an analysis was made of eleven general science textbooks in wide use in the high schools throughout the country. The copyright dates of these eleven books ranged from 1939 to 1949. Most of the authors of these books are widely recognized as teachers of skill and experience, and their opinions with respect to desirable content of the general science course must be accorded serious consideration. An analysis of the content of these texts is certainly one dependable guide to what is actually being taught in the general science course. Such analysis revealed reasonable uniformity with respect to subject-matter coverage. Table I summarizes information on the proportionate assignment of space to the various topics, and, for comparison, proportion of questions by topic in the final forms of the test. The curious regularity with which the figure 7 appears in this table is due to the fact that in the early days of

[1] One of the *Evaluation and Adjustment Series,* a comprehensive series of high-school tests being developed for publication by World Book Company. Tests in each major subject-matter area are being prepared under the direction of a specialist; for this and other science tests, Dr. Victor H. Noll, Michigan State College, serves in this capacity. The general editor for the entire series is Dr. Walter N. Durost of Boston University. Conduct of the experimental work here described was under the direction of Mr. Roger T. Lennon, Director of the Division of Test Research and Service of World Book Company.

TABLE I

PERCENTAGE CONTENT BY TOPICS OF ELEVEN TEXTS IN GENERAL SCIENCE COMPARED WITH CONTENT ON FINAL FORMS A AND B

Topic	Text %	Form A Form B %	No. of Items in Each Area Form A	Form B
Air	7	8	6	6
Water	7	4	3	3
Heat	7	6	5	4
Weather	7	8	7	7
Astronomy	7	7.5	5	6
Work and Machines	10	7.5	5	6
Mag. and Elect.	7	7.5	5	5
Chemistry, Fire	4	6.5	5	5
Bacteria	7	7.5	5	6
Human Body, Food	11	6.5	5	5
Conservation, Imp. Pl. and Animals	10	10	8	7
Geology	7	7.5	6	5
Sound	2	2	2	1
Light	2	3.5	2	3
Scientific Method	3	3.5	3	2
Communication	1	2	1	2
Transportation	1	2.5	2	2
Total biological	30	24		
Total physical	70	76		
Totals	100	100	75	75

general science, each of 14 topics typically had substantially the same amount of space devoted to it.

The second source of guidance in the determination of objectives for the general science course was a study of city and state courses of study. For the most part these courses, though comprehensive and detailed, were permissive in character. They did not require that all the content be taught; they suggested aids to be used if it were taught. There is almost no way of knowing how much is covered in any given general science class using one of these syllabi. Indeed, in almost every case, there is much more material than could possibly be covered in the science hour-schedule. The general feeling expressed by some of the introductions to these courses of study is that general science is an exploratory and tryout course, and while necessary for everyone as a matter of personal adjustment to the environment, need not cover every area of science. Local community conditions and the needs of the pupils determine the emphases on areas.

The recommendations of the various yearbooks and committee reports devoted to the field of general science over the last two decades also received consideration in determining the objectives which the test ought to cover.

Following the analysis of textbooks, courses of study, and other sources, an outline or blueprint of an achievement test was developed, indicating the approximate weight to be assigned to each topic in the final test. The determination of these weights was made roughly on the basis of the space and time devoted to the topic in the textbooks, together with the considerations of trends in emphases in the newer books and syllabi. The final blueprint for the test is shown in Table II. After this outline had been constructed and reviewed by experts in the field, test questions were developed in sufficient number to provide three experimental forms of ninety items each; all three forms conformed to the blueprint with respect to coverage of the various topics.

PRELIMINARY TRYOUT

In order to obtain information on the difficulty and the validity of the questions,

TABLE II

COMPOSITION OF ORIGINAL AND FINAL FORMS OF TEST AS TO OBJECTIVES

	I. To Achieve Understanding of: a. Functional Facts	b. Functional Concepts	II. To Achieve Skill in: a. Reading Charts and Graphs	b. Problem Solving	c. Complex Problem Solving	III. To Demonstrate: a. Scientific Attitudes
Column	1	2	3	4	5	6
Original Test	20%	30%	18%	16%	11%	5%
Final Test						
Form A	33%	33%	12%	7.5%	8%	6.5%
Form B	32%	34%	12%	8%	7.5%	6.5%
Aver. Form A and Form B	32.5%	33.5%	12%	7.75%	7.75%	6.5%

the experimental forms were administered, in the spring of 1949, to 1613 students in 11 communities from Maine to Iowa. Fourteen schools and 34 classes were included in this tryout group. An intelligence test (the *Terman-McNemar Test of Mental Ability*) was used as a means of checking the general level and range of intelligence of the group. The mean I.Q. was 102.42; the standard deviation, 15.26. It thus appears that the tryout group was reasonably representative of ninth-grade students generally. There is no reason to suppose, moreover, that this group is not in other respects typical of general science classes. The tests were given in general science classes by the teachers of those classes. The test was not speeded and substantially all pupils responded to every item. The three forms were administered to random thirds of the total group; these random sub-groups are known to be of equal ability.

The primary purpose of the preliminary tryout was to determine the difficulty value for each item and its validity or discriminating value. This preliminary tryout also served the purpose of revealing items which were objectionable from a content standpoint, ambiguous, or in other respects unsatisfactory. In the course of the tryout, all teachers participating were asked to criticize the test from the standpoint of coverage and difficulty, and the observations of these teachers were taken into account in planning the final forms of the test. The task of constructing the final forms of the test then became one of selecting from among all the items tried out, those items which were most appropriate from the standpoint of difficulty and discriminating power, while at the same time maintaining the proper distribution of content according to the original blueprint for the test—except insofar as the results of the tryout indicated that it was necessary or desirable to depart from this blueprint. The item-analysis figures also made it possible to develop two final forms of the test known to be equivalent in difficulty and validity.

With respect to difficulty, although it is usually considered that a test composed of items of 50 per cent difficulty yields maximum reliability and differentiation, it is seldom desirable that *all* items should be of this difficulty level. It is desirable to have some easier items in order to provide discrimination among the poorest students, and at the same time to have sufficient difficult material, so that even the best of the students will not make perfect scores. The range of difficulty values for the items finally retained for the final forms is from 38 per cent to 70 per cent, with an average value of 52.7 for Form A and 52.4 for Form B.

The item validity index used in this instance was the Flanagan approximation of the product-moment correlation between item and total score, computed from per cent passing in the upper and lower 27 per cent of the tryout group. The average validity coefficient for the two final forms

was .414 for Form A and .427 for Form B. The lowest validity coefficient of any retained item was .20; only seven items of the final 150 had validities below .28. In other words, every question in the final forms of the test is known to discriminate between good and poor general science students, thus contributing to an accurate ranking of the students in this subject.

Study of the time required by students to complete the preliminary editions of the test indicated that a 75-item test could be handled in a working period of 40 minutes, and consequently the final forms were planned as 75-item tests. The final forms of the tests were administered for standardization in schools throughout the country in the spring of 1950, at which time reliability studies were also undertaken. This article, however, is not concerned with the results of this standardization. The remainder of this article points out some of the implications of the results of the initial tryout of the material.

RESULTS OF TRYOUT

In the paragraphs that follow, the writer takes the position that the results of this item analysis tend to reveal the emphasis which teachers are placing on specific subject-matter areas. Three studies made in addition to this item-analysis experimentation have been in substantial agreement with the findings here reported.

Table I as mentioned above shows the percentage of items on the final forms of the test devoted to each topic. It will be seen that for the most part, the test corresponds fairly closely to the typical textbook in relative weight assigned to topics. Where there are differences between the textbook coverage and the test coverage, it may be assumed that for one reason or another the percentage of items devoted to a topic was permitted to vary from the original allotment, either because items in this area proved to be non-functional or because certain compromises had to be made, in order to stay within the pre-determined 75-item range.

It will be noted that only about half as much emphasis is placed on the topic *water* in the test as in the textbooks. *Work and machines* has dropped significantly, and questions on the *human body* and *food* are fewer in number than their weight in the textbooks would suggest. Insofar as the decision to omit some items in these areas was based on failure of an item to function (usually because of too great difficulty), it is suggested that teachers are not paying as much attention to these areas as was formerly the case. General science teachers see many, if not most, pupils taking an elective or required biology in grade 10 and so may omit material on biological topics which will be taught there. Many schools have elementary health programs, and information on nutrition is of course included.

The ratio of biological to physical questions corresponds closely to the ratio of these topics found in the analysis of the textbooks. This ratio is approximately 30 per cent to 70 per cent. Classification of this sort is not always easy; discussions of sound and light, for example, include material on the ear and the eyes, and hence may fall in both categories.

Table II permits a comparison of the final forms of the test and the original "blueprint" with respect to percentages of kinds of questions. Here again, departures from the "blueprint" were made when the item analysis data indicated that such changes would lead to more valid measurement. It will be seen that items classified as measuring "functional facts," which include vocabulary items, loom larger in the final form than in the early specifications, reflecting the fact that these items stood up very well in the tryout, and seemed to be effectively discriminating.

Questions on functional facts and concepts were increased, relatively, at the expense of questions on reading of charts and graphs, and problem solving. Despite general agreement on these latter as important objectives, items dealing with them proved excessively difficult, and of less differentiat-

ing value; hence, fewer of them appear in the final forms.

Questions having to do with the "scientific attitude" in general proved valid, if somewhat difficult.

While some teachers may feel that a test is too difficult when only about half the items are done correctly by the average ninth-grade student at the end of the year, it must be remembered that the range of achievement in general science is very great. There are many students whose extra-curricular activities are largely concerned with experimenting and reading in the science field; many of them have home laboratories or prepare projects for local, state, or national science fairs. They should have an opportunity to exhibit their ability on any standard science test; teachers can then better advise, encourage, and guide them to further science experiences in school and out. To be sure, the school will often take credit for superior achievement by its students in the field of science as demonstrated by high scores on standard tests, when in fact that achievement is the result of extra-school activities. However, for each student who does well for this reason there is another for whom the interest and encouragement of the teacher has meant everything, and has stimulated a hitherto unknown aptitude which comes to fruition in a few years of study in science. Any good science test must therefore provide a high ceiling for the recognition of what is coming to be called "science talent."

If high scores are made by a student on this test, and on a good test of mathematical ability, the teacher should investigate the possibility of more science training for this young person. There is an ever-growing shortage of able workers in the fields of science and mathematics. Perhaps it is not too much to say that unless science talent is discovered and encouraged at the junior-high-school level or before, the kind of world we now live in will find itself without competent control.

PREPARING HIGH SCHOOL STUDENTS FOR THE ATOMIC ERA

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ALMOST immediately after America's victory over its enemies, in 1945, advance-guard thinkers in education, politics, and science began expressing alarm about the seeming indifference of our citizenry toward the atom and all its implications. Interest soon died down from a fever pitch, or an incandescence (if one wished to make a pun), to a cold acceptance—a burned-out resignation. Whether the public has turned away from its initial interest in the atom bordering on fatalism, loss of interest in the sensational, sheer boredom with all war-born prodigies, lack of intelligent self-interest, or because of a willful desire to find a Nirvana of contentment in a happier employment of leisure hours, will make no possible difference, if our country should some day find itself outdistanced by its enemies.

Writing in the "New York Times" recently Leonard Buder quotes Professors Evans and Crary as saying in Columbia University's "Teacher's College Record" that "on the whole, not nearly enough effort is being made by public schools to help young people and adults with the critical situation that the world faces today," in respect to teaching the full implications of atomic energy. These writers ascribe the lack of effort along these lines partly to the tendency to shift responsibility for atomic education to "community-agency" shoulders, and partly to fear that the comprehension of atomic science will be too difficult. Our citizens forget, of course, that social

and economic implications can overtake the layman without waiting upon a highly specialized scientific grasp by him of the subject. If for no other reason than as a corrective to the mistaken idea that atomic energy is useful only as a weapon of war, schools should be teaching atomic science and what might be termed "atomic social science." If we are to realize all the promise for good which the atom holds for society we must start now to orient young minds *toward* the atom as a wellspring for peace-time blessings and away from the atom as an engine of war. It is time for emphasis upon the atom in peace.

Axiomatic as these ideas may appear, recommendations to date have urged the addition of teaching units on atomic energy to already existing courses in science and social studies. This results in a division of responsibility and is apt to be attended by the usual consequences of such division, namely, difficulties in selecting material, budgetting time, selecting traditional material to be eliminated in order to make time for atomic matters, etc. It would therefore seem much more effective to establish a separate course in atomic education as a free and independent entity in the high school curriculum. Science and social studies teachers could continue to teach atomic science as a related subject wherever and whenever they meet it in their daily presentations. This "incidental" treatment can be very valuable, but we should not content ourselves with a somewhat hit-or-miss procedure. We should provide a definite time and place for an independent treatment of the subject. These and other similar considerations have led to the formulation of the following course:

COURSE ON ATOMIC SCIENCE

The aims of this course are to:

1. Orient talented students toward considering careers in various atomic fields—i.e., engineering, chemistry, medicine, biology, etc.

2. Create the background for an understanding of atomic matters on the part of those who in the future may find themselves leaders in non-technical fields where atomic energy may play a role: politics, economics, industry, etc.

3. Make intelligently-informed citizens by spreading a knowledge of atomic science and its social implications.

THE SEVEN UNITS OF THE PROPOSED COURSE

Unit I. The Physics and Chemistry of the Atom

A. History of the development of our present idea of the atom:
   1. The Greek idea
   2. Discovery of the several sub-atomic particles

B. Diagrams of atoms.

C. Early attempts at transmutation

D. Modern success at transmutation
   1. Bombardment with alpha particles; Van de Graaff electrostatic generator, cyclotron, betatron, etc.
   2. Wilson cloud chamber
   3. Four new trans-uranium elements prepared

E. Types of radiation—nature, source, effects

F. The Einstein equation—its consequences (matter and energy relations)

Unit II. Warfare and Atomic Science

A. The Atomic Bomb
   1. History and locations of Manhattan Project
   2. Ores of uranium—location, identification, composition
   3. Geiger counters; radioactivity
   4. Separation of isotopes of uranium
   5. Atomic fission—chain reactions—nuclear pile
   6. The atomic bomb—its probable mechanism
   7. Tests and use of the atomic bomb—Alamogordo, Hiroshima, Nagasaki, Bikini, Eniwetok—lessons learned from these

B. Defense against the Atomic Bomb
   1. None known or believed possible
   2. Reasons for this belief

C. Military Strategy and implications of use of the Atomic Bomb
   1. Sooner or later all countries will be able to make Atomic Bombs
   2. Necessity of decentralizing our cities and industries
   3. Maintenance of strategically located military bases and control of strategically important raw materials
   4. Necessity for strengthening foundations for International Peace

Unit III. Biology and Atomic Science

A. Effects of radiation upon cell contents and behavior of cells so treated

B. Agricultural implications—genetic changes possible, resulting in improved species
C. Tracer atoms—how used in research

Unit IV. Medicine and Atomic Science

A. Cause of destructiveness of the Atomic Bomb to human beings—damage to blood platelets, blindness, concussion effects, falling debris, delayed effects
B. Medical implications of the Atomic Bomb
   1. Colossal blood-banks needed for treatment of victims of a raid, problem of which victims to select for treatment if blood-bank inadequate, etc.
C. Medical benefits of radioactivity:
   1. About ten elements have been found of great value in treatment and as research tools (tagged or tracer atoms) already, i.e., Carbon 14, Sodium 24, Phosphorus 32, Iodine 131, Iron 55, Sulphur 35, Chlorine 36, Gold 198, Potassium 42, Calcium 45—all are radioactive isotopes

      "Some medical authorities believe that atomic energy, in the form of isotopes, has already saved more lives than it destroyed in both bombings of Japan."
   2. Tremendous strides possible not only in treatment of cancer and other little-understood diseases, but in invention of new methods in surgery ("neutron knife"), vaccine preparation, etc.

Unit V. Industry and Atomic Science

A. Isotopes now used widely in metal, oil, and other industries—iron and steel (Bessemer process) as checks and controls; plastics; etc.
B. Heat from nuclear fission for steam and electric power
C. Possibilities for improvement of industrial products through use of radioactivity is unlimited
D. Need for trained research workers in industry, science, and medicine

Unit VI. Political, Economic and Social Implications of Atomic Science

A. Control of atomic energy
   1. Control on the national (internal) scale (United States Atomic Energy Commission)
   2. Need for control on the international scale
   3. Attempts already made
      (a) Baruch plan
      (b) United States Atomic Energy Commission
      (c) Cause of failure of U.N.
B. International relations and the Atomic Bomb
   1. Impossibility of maintaining the "secret" of the bomb—contributions made to atomic studies by nationals of U. S., England, France, Germany, Denmark, Italy, Canada, Russia, Japan, etc.
   2. Advantages of international cooperation in scientific research
   3. The psychology of fear, and its consequences

Unit VII. What each of us can do to help make the Atomic Era a blessing rather than a curse

A. Become intelligently informed by wide reading (books, magazines, newspapers), attending lectures and forums, listening to good radio programs, etc.
B. Initiating and helping with community projects to inform our neighbors on atomic matters—exhibits, taking part in forums, discussion groups.
C. Urge adequate support for research

Materials: Textbooks * . . . pamphlets, magazine articles, charts, films and film slides, apparatus in stock in physical sciences and natural sciences departments.

Method: Lectures by teacher, supplemented by outside reading (Units I and II), films, exhibits, charts, reports by individual students on parts of Units III, IV, and V, round table discussions on parts of Units VI and VII, visitors from outside and visits to any nearby laboratories, i.e., University laboratories, hospitals, etc.

* . . . Names upon request.

National Council for Elementary Science

February Meeting in Boston with ASCD Being Planned by Mr. Blackwood. April Meeting in Philadelphia with ACEI Being Planned by Miss Young.

PRESIDENT: Julian Greenlee, Western Michigan College of Education Kalamazoo, Michigan

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A BIBLIOGRAPHY OF CURRICULUM MATERIALS IN SCIENCE

HUGH B. WOOD AND HOWARD IMPEVOCEN
University of Oregon, Eugene, Oregon

INTRODUCTION

MANY teachers, supervisors, and administrators frequently ask, "Where can I find a good course of study in Science?" or "What are other schools doing in Science?" This article lists some of the more recent materials that have been prepared for specific school situations. Some offer definite suggestions; others are quite general. Some represent fusion programs; others are more conventional subject programs. Among them there should be some that will be helpful to all teachers.

No claim is made for comprehensiveness. The following criteria guided the selection of these materials: [1]

1. For the most part, only materials prepared by teachers and administrators and issued by school systems have been included.
2. Evidence of conscientious workmanship and effort (with a limited amount of the "scissors and paste" technique) was considered more important than adherence to a specific philosophy or type; an effort was made to include a *cross-section* of good materials of all types and points of view.
3. Most of the materials included have been prepared since 1945.
4. All of the materials have been recommended by some professional publication or by a local or state administrator or a curriculum specialist.
5. The selection is limited somewhat by availability inasmuch as some school systems are not willing to release their materials to curriculum laboratories and others outside their own systems.
6. Although a rather extensive searh of the literature was made, including the *Education Index* and other bibliographies, undoubtedly many excellent materials were not uncovered and thus have not been listed.

The compilers plan to revise this bibliography from time to time. They would appreciate suggestions and information relative to errors and omissions.

All annotated items were personally examined by the compilers; others are included on the basis of strong recommendations.

[1] Professor Wood selected the materials and organized the bibliographies; Mr. Impevocen prepared the bibliographic entries and the annotations.

SCIENCE

Boston, Massachusetts. *General Science for Intermediate Grades.* Boston Public Schools, 1946. 287 p.

Represents a carefully selected group of science problems; each unit deals with some aspect of the pupils' environment and is composed of a series of experiments arranged in logical order from the more common and earliest science experiences to the more complex science experiences that begin to unfold themselves to the growing child.

Brockton, Mass. *A Course of Study in Junior High School Science.* Brockton Public Schools, 1942. 234 p.

Trains for intelligent citizenship by providing the pupil with experiences which will help him to understand his environment, which will give practice in the use of the scientific method and which will tend to develop a scientific attitude toward the problems of life.

Brookline, Massachusetts. *Course of Study in Science Grades 1–3, and ...4–6* (2 volumes). Brookline Public Schools, 1946. 69 p. and 101 p.

Covers three parts: (1) the earth on which we live and the surrounding universe; (2) life, its varieties, needs and conditions for survival; (3) forms of matter, physical and chemical forces and inventions. These units do much to acquaint the child with larger concepts and appreciations that come in later grades.

Cedar Falls, Iowa. *Sources of Elementary Science Materials.* Iowa State Teachers College, 1950. 21 p.

Lists pamphlets, textbooks, workbooks, audio-visual aids, references, method materials, professional books, courses of study, resource units, and free and inexpensive materials for elementary science.

Des Moines, Iowa. *High School Atomic Energy.* State Department of Public Instruction, 1950.

Elkhart, Indiana. *Course of Study Elementary Science.* Elkhart Public Schools, 1946. 61 p.

Introduces science activities for the intermediate grades through observing, experimenting, reading, keeping records, using visual aids, art work, and asking questions. Believes that the child lives with people in a world of things—elementary science deserves equal emphasis with social studies in this reasoning.

Emporia, Kansas. *Making Elementary Science Meaningful.* State Department of Public Instruction, 1949. 226 p.

Suggests approaches, activities, integration, bibliographies, and helps for the teacher; arranged in ungraded style, the material stimulates interest as well as saves time.

Houston, Texas. *Biology I—II Handbook.* Houston Public Schools, 1950. 70 p.

Considers each course in science which the student takes as only a part of his total scientific knowledge, and should be considered as such and not as an independent unit. Stresses heavily those principles and facts which are directly associated with everyone's daily living in biology.

Houston, Texas. *Physics I—II Handbook.* Houston Public Schools, 1951. 50 p.

Gives units of work intended to help the student equip himself for a better, happier, more useful, and more stabilized life through a practical knowledge of such things as sound energy, light energy, energy as applied to machines, electrical energy, magnetism and electromagnetism, radio, atomic energy, energy of bodies in motion gravitational forces, energy as applied to molecules.

Houston, Texas. *Science Handbook Junior High Schools.* Houston Public Schools, 1951. 54 p.

Aims to develop in the student the ability to collect scientific data and apply scientific thinking in the solving of problems and the answering of questions. Repetition is an often-used and effective type of emphasis which has been used in several instances in this course of study and has been done so intentionally.

Houston, Texas. *Science Outlines Kindergarten–Grade Six.* Houston Public Schools, 1951. 44 p.

Provides a program from kindergarten through grade six that has been planned so that certain major topics appear in each grade; but in each succeeding year the pupils attack these problems with increasing maturity. Provides for gradual growth and development, avoiding useless overlapping of experiences.

Lincoln, Nebraska. *Science for Nebraska Elementary School Children.* State Department of Public Instruction, 1950. 204 p.

Places the emphasis throughout upon first-hand observation by the pupil and his actual performance of activities carefully designed to result in significant outcomes. The content embraces five major areas of science for elementary pupils: earth, heavens, energy, living things, and man's control of his surroundings. For the purpose of effective instruction, each of these five major acreas has been broken down into several sub-areas.

Los Angeles, California. *Science—Source Book for Elementary Schools.* Los Angeles Public Schools, 1950.

Milwaukee, Wisconsin. *Teaching Science in the Elementary School.* Milwaukee Public Schools, 1950. About 40 p.

A series of resource units covering the subjects of parasites, aluminum, force and motion, magnetism, the earth and its neighbors, pets, and birds. Units are well-constructed, practical, and thorough; age range is from primary grades through high school.

Mishawaka, Indiana. *Elementary Science, Grades 1, 2, and 3 and ...4, 5, and 6.* (2 volumes.) Mishawaka Public Schools, 1949. 106 p. and 95 p.

Outlines eight units for each grade in grades one, two, and three; in grades four and five, each grade has been assigned six units; in grade six, five units have been suggested. Assigns fewer units to upper grades because the increased maturity of the older children should make possible more intensive work in the upper grades. Units are well-constructed, and have been carefully selected and planned so that they will ever continue to foster a question, and thus broaden and enrich their outlook upon an understanding of the world in which they live.

New York, New York. *Animals on Parade.* Board of Education, 1951. 64 p.

Aims to bring to primary school children authentic information about New York's zoos, and wild animals in general, to foster humane education, and to give students an understanding of the need for conservation of our wild life.

New York, New York. *Applied Chemistry for High School Students.* Board of Education, 1949. 79 p.

Represents an attempt to adopt the science of the senior high school to the objectives of general education, and provides for the general interests of boys and girls as well as for the community interests of the individual schools.

New York, New York. *Science in Everyday Living.* Board of Education, 1948. 87 p.

Generalizes science experiences for early grades as a general part of the curriculum rather than a separate subject in the curriculum; useful as a source book for many experiments by youngsters.

Sacramento, California. *Science in the Elementary Schools.* State Department of Education, 1945. 418 p.

Based on the belief that science in the elementary school will achieve its goal to the extent that it helps the child to interpret the world in which he lives and to react intelligently to it. Contains a wealth of photographs and units that can be adapted for use in any schoolroom in any location. Unusually well done.

Sacramento, California. *Course of Study in Photography 8 for Senior High Schools.* Sacramento Public Schools, 1950. 46 p.

Establishes a one semester course organized around four major fields of photographic experience which include the function of the camera, the development, printing, and enlarging of pictures, the use of adjustable cameras, and the handling of certain special problems in photography. The teacher is given suggestions relative to study questions, references, vocabulary emphasis and tests.

Sacramento, California. *Course of Study in Physics 7 xy and Psysics 8 xy—Senior High*

Schools. Sacramento Public Schools, 1950. 13 p.
Offers a two semester course in physics at either the junior or senior level. The course has been divided into units: each unit is then divided into sections and topics. Opposite each topic there are suggested methods of procedure and the text from which the students can find material on the topic.

Sacramento, California. *Course of Study in Science for Elementary Schools.* Sacramento Public Schools, 1949. 92 p.
Suggests excellent outlines for science begining with the fourth grade. The work is carefully done, is complete in coverage, and contains exhaustive suggested procedures to further enhance the value of the units.

Sacramento, California. *Course of Study in Science for Junior High Schools.* Sacramento Public Schools, 1949. 60 p.
Summarizes work that had been presented in tentative form for the junior high school science program; units are thorough and helpful; they are outlined according to the season in which they are to be taught. Especially interesting are the suggested procedures for each of the units developed.

Salem, Oregon. *Learning About Atomic Energy.* State Department of Public Instruction, 1950. 31 p.
Prepares units to assist ninth grade science and senior social studies teachers in helping students gain the knowledge and develop the understanding necessary for informed existence in an atomic era. Since high school is the last formal education for a majority of Oregon's young people, secondary school teachers have a special responsibility in the development of an awareness in students of the social and scientific implications of atomic energy. Lists suitable materials for assisting in this endeavor.

Salem, Oregon. *Science for Oregon Schools.* State Superintendent of Public Instruction, Part I (Elementary), 1948. 109 p. Part II (Secondary), 1949. 181 p.
Stresses experiencing, observing, and the actual functioning of science in the lives of Oregon boys and girls, and in the society about them as the elementary and secondary school programs of a sequential twelve-year movement.

Washington, D. C. *The Teaching of Science in Public High Schools.* Federal Security Agency, Office of Education, 1950. 48 p.
Samples current science materials and practices as offered in 755 carefully selected high schools; reports that the troublesome problems are most commonly related to physical facilities such as equipment, supplies, rooms, and school.

PHYSICS FOR THE BLIND

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CURRENT educational philosophy suggests that "the blind should no longer be set apart in school and society, but become an integral part of it." Practically, this means that blind students, after completing the unexcelled specialized training in their resident schools, may now be "farmed out" to public secondary schools.

While academic subjects such as English, ancient and foreign languages, the social sciences, typing, music, etc., offer no special problems in methodology for the sight-handicapped, physics offers a distinct challenge to the teacher. Here, special methods, techniques, tactual demonstrations, and braille-labeled models may be adapted to use in both classroom and laboratory.

An awareness of physical phenomena is essential in order that the blind may make satisfactory life adjustments in their circumscribed sphere of existence. Physics, then, is a subject worthy of consideration in evolving a workable content and methodology for blind instructional purposes, with bright seeing students serving as group instructors in the laboratory.

To illustrate how the blind student necessarily reacts to his physical environment: he recognized an automobile, diesel engine, airplane, steam locomotive, or a jet propelled engine by sound. He switches on the fan, or heater, tunes the radio, and judges distances by sound. He responds to heat radiated by a stove or hot object so that he avoids actual painful contact. He can feel the wind on his face, hear hissing steam, a kettle boiling, and note how much easier it is to push the piano with the wheels on the legs than to move it without them. He can recognize friction shown by the sound of squeaking noises in machines, and feel the heating effects of frictional

resistance. He can note condensed water on the side of the ice water pitcher, smell gas from the gas range, and tactually recognize the cooling effects of evaporation after a swim or bath. He can get an electric shock when his finger touches a live contact, and feel the radiant heat from an electric bulb. The see saw, scissors, and the crow bar are understandable as tactual demonstrations of the lever. Through comprehension of such physical phenomena, he gains some valuable knowledge of the circumscribed world about him. The major units of physics, some of which may suggest possible vocations, include light, sound, matter, mechanics, hydrostatics, heat, magnetism, electronics, radio, jet propulsion, etc. These varied topics are ostensibly as important and interesting to the blind students as to the seeing.

As a teaching aid blind students should be encouraged to make a braille note book in physics, with embossed or depressed diagrams as tactual illustrations, and interpret the mathematical problems involved on their cube or type slates.*

Light. The subject of light is probably the one topic to be avoided. To the congenitally blind, the light unit is usually a hopeless mixup of unintelligible words and meaningless phrases. Therefore, other more comprehensible physics units should be substituted. To the adventitiously or partially blind, the light unit may be taught with some emphasis on the value of optical instruments as sight conservation or corrective measures.

Sound. Because auditory acuity is one of the blind student's chief assets in his daily environmental contacts, the sound unit should be given detailed attention. The absence of sound in vacuum is an effective experiment, demonstrated by an electric bell inside an evacuated bell jar; as the air is exhausted, the sound ceases.

The role of sound waves in submarine detection devices using the conduction of sound waves underwater may be demonstrated by reference to swimming underwater while a motor boat is passing. The reflection of sound in the reverberations heard during a thunder storm is also interesting to the blind in quelling possible innate fears.

Good music is appreciated by the blind, many of whom learn to play a musical instrument as a hobby or even as a vocation. The vibrations of sound may be demonstrated by feeling the plucked strings of various stringed instruments. Models impressed in clay and raised linear or embossed diagrams labeled in braille may be used to tactually differentiate types of sound waves. The blind student may synchronize and tune musical instruments, comparing harmonic vibrations with discord. The tuning fork in resonance is meaningful to blind students, as are sympathetic vibrations, which are quickly detected by the astute blind listener. The scientific explanations of differences concerning regular and irregular vibrations with frequency greater or less than 20 vibrations per second is interesting. Pitch, volume, and quality of sound are topics for laboratory experiments. Those sightless students, having a practical knowledge of resonance, have open to them a possible vocation; i.e., piano tuning.

Matter. The three states of matter, solid, liquid, and gas are quite tangible to the blind. The identifiable properties of matter, such as odor, brittleness, malleability, ductility, tenacity, and hardness may be tactually presented to the blind using sulphur, ammonia, glass, lead, copper wire, steel, and carborundum as examples. The difference between chemical and physical changes may be tactually presented by noting ice as frozen water, the melting of snow and vaporization as physical changes, and the burning wood as a chemical change.

* *The type slate* consists of a series of octagonal slots into which plugs marked with two dots or a dash are inserted and twisted. By moving the plugs around and lining them up according to required numerals, addition, subtraction, multiplication, and division problems may be worked out and recorded.

Physical Measurements. The visionless student should gain accurate concepts of the different units of measurement by handling measuring instruments. He should learn to estimate the length of familiar objects using a meter stick, and units of area as represented by cut-out models. To gain concepts of volume, regular objects, such as the sphere, prism, cube, and cylinder should be given to the blind for manipulation. They can be required to figure the volume of a rectangular block by mental arithmetic or by using their type slates. The blind student should feel what happens when a solid is immersed in water; i.e., apparent loss of weight of his own body by displacement of water in his bath.

Pressure. The air pressure units with the usual laboratory mercurial or commercial instruments present some perceptual difficulties to the blind. They may, however, feel the weight of mercury in a container and note the tactual appearance of the apparatus. The instructor may then inquire why the mercury rises in the tube and how altitude affects the air pressure as a utilitarian application of the principles of the barometer. Both force and lift pumps may be demonstrated to the blind by tactual manipulation of model pumps, aided by the teacher or student group leader.

Motion and Energy. The unit pertaining to motion and energy is a useful and practical field for the blind. They should be able to apply Newton's four laws of motion to daily activities using their kinesthetic senses. The force, work, energy, and power units represent vital topics within the realm of student comprehension. Energy problems may be referred to comparable topics using model set-ups such as dams and water wheels, thus showing ability to do work. Kinetic energy is demonstrated by throwing a ball; potential energy, by catching a falling ball and then holding it.

Heat. The heat unit also has obvious utilitarian value to the blind. Starting with the sources of heat, the teacher should demonstrate them practically. Rub a piece of metal on hardwood, or pump air into an inner tube, and the tube feels warm. Why? Thermometry and the principles of expansion of liquids and solids may be taught if guided by a teacher or group leader. Coefficients of expansion of gases, gas law problems, and interpretations of formulae involved are not too difficult for the average blind high school student. He should be tactually familiar with heat conduction and insulation to prevent possible burn injuries.

Recognition of various insulators, as well as the heat conductivity of various metals, links conductivity with his sense of touch. The blind should recognize proximity to hot objects through their delicate tactile sense and know when not to touch any surface that emanates heat. Dew point and calorimeter experiments may prove interesting, however the specific heat problems, are usually too intricate for the average blind student to follow.

Vaporization, condensation, and boiling are natural everyday phenomena, which can be explained to the blind, who may cautiously feel steam rising from a kettle, thus demonstrating both vaporization and condensation. Evaporation may also be tactually presented by placing drops of water, alcohol, and ether on their hands and allowing them to note the comparative cooling effects. It might be well to suggest some health aspects of humidity, etc. A cutout model of a steam or hot water heating plant may be followed by tactual examination of home and school radiators, etc., to terminate the heat unit.

Mechanics. Simple mechanical movements may be taught the blind when the apparatus can be felt and results interpreted by tactual observations. The pendulum, gravity, and equilibrium demonstrations with appropriate laboratory exercises are topics that have some application to the blind student's kinesthetic sense. The pendulum is a swing while gravity represents a fall. The motion and velocity units are within the blind's comprehension also, provided that the mathematics required for the full mastery of the unit is not too

stringent. The sightless students are quite apt to have use for simple machines in their daily routine. The lever, inclined plane, wedge, wheel, pulley, and screw can be fully understood when taught through laboratory experiments and braille reading assignments. A dissected modern steam engine can be used to show the working parts of engines in general. The automobile can be demonstrated by the tactual study of models, but caution must be used in the manipulation of moving parts.

Magnetism, Electricity, and Electronics. The principles of magnetism using bar, horseshoe magnets and the compass can be taught by tactual observation techniques. They can feel iron filings pattern lines of force with their sensitive finger tip touch. In static electricity, the student may pick up fragments of electrified paper with a vulcanite or ebonite rod. Water running through tubes is a tangible aid to the elementary concepts of electrical units, for we might parallel this topic to the pressure, volume, and resistance of water coming out a faucet. The pressure of water shooting from a fine nozzle can be compared with E. M. F. or voltage, and the amount with current flow or amperage. Tactual aids such as the dry cell may be safely used to make series or parallel connections and to figure out the ohm, ampere, and volt output.

Teaching electrical problems involving reading instruments presents some difficulties, however, bright seeing students may read and interpret the results for the blind group. Electro-magnetism may also be demonstrated by the careful manipulation of a model dynamo, an electric bell, an induction coil, a transformer, or the telegraph, etc. The writer feels that the blind could master telegraphy as a profession by transmitting Morse Code and receiving messages directly on the typewriter or in braille.

The blind student should be well versed with insulating surfaces, switch handles or knobs to avoid the dangers of handling modern electrical equipment. Allow them to feel the heat generated by radio tubes, etc., so that they will take the proper precautions in tactual observations. The phenomena of rebounding radar rays can be demonstrated by noting the ripples in a tub of water when an object is dropped into the water. Nuclear physics and atomic fission are modern topics that the blind, no doubt, want to know something about. Tactual models of atoms made from wire loops and beads, etc., are aids in the teaching of this unit.

The writer realizes that a little knowledge of the sciences may be dangerous, especially to the blind. Nevertheless, sightless persons are brought into daily tactual, auditory, oral, and olfactory contact with the many mechanical and electrical devices necessary to our modern complex civilization, and physics should be the educational bridge to be crossed for their comprehension.

A RE-EXAMINATION OF *DESERTS ON THE MARCH*

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THE face of the earth is but a graveyard and so it will continue to be until man either eliminates himself or restores the ecological balance which he has so violently disturbed. Following such an introduction, in *Deserts on the March,* Dr. Paul B. Sears has with broad strokes and without pedantry presented his concepts regarding these matters in a quite orderly fashion, so that the volume has reached a wide reading public. Such a book popularizing the subject and revealing ecological balance as the essence of the field has no doubt been an important factor in this author's selection to head the nation's first university program in conservation (Yale University)

offering graduate work in this field. Quite probably this book has also been influential in fostering the organization of the second university conservation unit now in process of establishment at the University of Michigan. Thus, Dr. Paul B. Sears' labors have borne fruit and it seems only fitting that a re-examination of his writing should be made as he occupies this first Chair of Conservation in the nation.

In a sense *Deserts on the March* may be considered as a prelude to William Vogt's *Road to Survival* and Fairfield Osborn's *Our Plundered Planet* for its appearance about a decade before the publication of these latter two helped prepare the way for the more widespread dissemination of the conservation idea. As a prelude to the writings of Vogt and Osborn, it is not surprising that the book is not so broad in scope or so comprehensive in area. Yet within the span of his efforts, Sears has in a pleasant and readily digestible manner, presented worthwhile, thought-stimulating ideas. *Deserts on the March* also precedes the books dealing largely with conservation by Sir Albert Howard and Louis Bromfield. Interestingly enough, numerous ideas are held in common by all these men, but whereas Howard and Bromfield usually rather clearly and concisely express their concepts, the same are rather frequently implied by Sears. Perhaps this is an example of how certain ideas evolve and pyramid from a base into pointed clarity. For example, what Sears refers to as "loans and redemptions" evolved into "the cycle of life" as expressed by Howard and Bromfield.

Although picturesque and descriptive, the title selected for this book could be misleading to many readers in the popular field who possess ingrained concepts as to what constitutes a desert—perhaps this is unfortunate. Also with the exception of three brief chapters at the beginning, the book is based almost entirely on a consideration of the evolving of the situation in the United States today. While this does perhaps bring the matter closer to home for many of his readers, it does not provide much idea of areal extent and overall seriousness of the conservation problem throughout the entire world. However, as a prelude to Vogt and Osborn, it does prepare the way by starting the American readers on familiar ground. Though the validity of some of his ideas is today subject to question, such as the matter of fallowing, nevertheless his basic premises remain sound.

No doubt Sears has suffered attack from many sides regarding his statements concerning such matters as banking economics, the system of leased grazing rights, and our system of taxation and private ownership. Nevertheless, he does make suggestions which have at least momentarily aroused people from their usual lethargy regarding these matters in relation to efficient utilization of resources.

Very worthwhile is his contribution concerning the fact that correct long-term handling of soils in the fields at the same time does much to restore wild life in streams and lakes. As opposed to this, he feels that it is our smug satisfaction in the clever, efficient, and speedy solving of immediate problems, without regard to their general setting which has placed us in our present predicament.

As a biologist, it is not surprising that he points to nature's grassland carpets as exemplary of the pattern we need to follow. Thus, he is somewhat ahead of the general movement toward greater recognition of grassland farming in this country. In fact, only quite recently has proof been provided that top quality soils in the best localities can produce feed (not food) in as great amount and frequently in higher quality when the land is properly used for pasture rather than for grain production. Yet Sears, prior to such proof, had apparently reached a similar conclusion. This is, of course, contrary to such arguments as the raising of corn on the best soils because it produces the most feed per acre. Thus, in numerous ways Sears in writing *Deserts on the March* was a decade or so ahead of his time.

Dr. Paul B. Sears seems highly in accord with Dr. Carl O. Sauer in believing that possibly we are now in an inter-glacial rather than a post-glacial period, and that it is not merely soil, plant, animal and weather which we need to know better, but rather man himself and his cultural evolution.

His conclusion that grassland and forest must be restored and protected to an extent not yet even dreamed of, as they represent sources of certain return under all conditions, clashes with those who advocate a greater areal expansion of plow agriculture to provide more food. Nevertheless, the case he has provided is as a whole quite sound, and it should stand long and weathering attacks from those of lesser stature and less experience in the restoration of ecological balances. Finally, he quite correctly deduces that education alone will not suffice but greatest success will only be achieved when man has acquired what Aldo Leopold has termed an "ecological conscience."

SELECTING SCIENCE TEXTBOOKS

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THE textbook is an object of universal use and interest, of which it has been said—"It is the textbook that in thousands of classrooms determines the content of instruction as well as the teaching procedures. In view, therefore, of the important place of the textbook in our educational practice, the preparation and selection of textbooks is a problem of major importance." [1]

It is of value to the teacher to have some idea of the purposes, advantages, and the content of textbooks. It is especially valuable to those using textbooks to know something of their selection, since it is probable that at some time everyone has the responsibility of making recommendations and suggestions for new texts.

Many textbooks have been built around courses of study, especially courses used in New York, and some courses of study have been built around a textbook. Hunter, in his book *Science Teaching* gives a number of uses and advantages of textbooks. The reader is referred to this source for details.[2]

In considering the matter of selection proper, it should be remembered that—"The educational interest of the pupil must at all times be the primary consideration in appraising plans for making and selecting textbooks." [3]

A number of factors have created a need for evaluation: (1) the multiplicity and variety of texts; (2) the variation in points of view; (3) the varying objectives of school systems; (4) the influence of committees on the reorganization of subject matter; (5) the utilization of scientific studies; (6) variation in distribution of space; (7) variation in organization of material; (8) vocabulary difficulty.

There are a number of methods commonly used by those evaluating textbooks. These methods range all the way from completely subjective analysis to an objective evaluation. Some try the books out in classrooms, others get advice from administrators and supervisors. A method mentioned frequently and used in a variety of forms, is the check list or score card.

There are a number of advantages to the use of a score card or check list in the evaluation of texts. For one thing, such a card or list tends to keep the points before a person doing the evaluation and when completed serves as a record of judgment.

[1] National Society for the Study of Education, *Thirty-first Yearbook*, Part II, Bloomington, Ill., 1931, p. 1.

[2] George W. Hunter. *Science Teaching*. New York: American Book Company, 1934, pp. 232–234.

[3] *Thirty-first Yearbook*, p. 305.

This record can be compared with the judgment of other individuals using the same card, and thus help to reduce the subjectiveness of such an evaluation. The most important thing that a card does is to direct attention systematically to the various items which are to receive attention. Most score cards, however, represent only the opinion of the individual constructing them, and sometimes are not as objective as they might be. Cards are sometimes constructed with a certain book in mind.

Two interesting observations in relation to score cards can be made from the study of textbook selection by Whipple.[4] (1) The number of items is about one-third greater when a score card is used than when it is not used. (2) Score cards are in general more explicit and contain a greater number of sub-points to aid in the evaluation.

No matter what method is used in evaluation there are difficulties involved. Many books that appeal to the teachers do not stimulate interest in the students. The teachers find their interests treated and read their own knowledge and experience into a book. There is also the problem of what criteria to use.

In an examination of material used in score cards, it was found that many criteria were mentioned and several types of score cards used. The score card which accompanies this article is patterned somewhat on that given by Hunter, although a number of new items have been added and the others rearranged.

Criteria omitted from the score card intentionally because of a doubt as to their validity were: copyright date, price, publisher and author. Author and reputation were omitted even though studies have shown that they are used by about twenty-five per cent of those employing score cards. The following quotation best expresses the majority opinion concerning the importance of the author in judging a book:

[4] Gertrude Whipple. *Procedures Used in Selecting School Books.* Chicago: University of Chicago Press, 1936.

"All such items (author, etc.) are of no importance in choosing a book. In fact it would be highly desirable if the authors' names and connections as well as that of the publishers could be entirely eliminated in making the selection. . . . it is a good book regardless of who wrote it and regardless of whether his name appears in this or that reference list. You are choosing a book on its merits and not upon a reputation of its author, often gained in other ways. You are interested in the book regardless of its author. . . . checking the author will not alter the value of the book in the least."[5]

Much more detail could have been included in the card but it was felt unnecessary. Such details as margin width, type size, vocabulary analysis, illustration analysis, etc., while of some use in evaluation were not considered suitable for inclusion. It was presumed anyone using a score card would first do some preliminary reading on the subject.

It should be noted that the score card is a weighted one and as such is rather subjective since it leaves to the examiner the decision as to the value in points for each item listed. This subjectivity can be compensated for by having several people evaluate the book or books in question and comparing the score cards.

A question the reader will have to decide for himself is how high a rating a book should have to be acceptable. Quite obviously if several books are being compared and one ranks considerably higher than the other it should be selected. If it should happen that several books rate the same the evaluator will have to be subjective in making his decision. Another possibility which should be considered is a book which rates high in most items but is poorly bound. Such a book would have to be discarded even though having a high rating.

The reader should not be discouraged because of the drawbacks mentioned above. Even though textbook selection by use of a score card has some disadvantages they are far outnumbered by the advantages.

[5] David F. Miller and Glenn W. Blaydes *Methods and Materials for Teaching Biological Sciences.* New York: McGraw-Hill Book Company, Inc., 1938, p. 115.

A SCORE CARD FOR THE EVALUATION OF SCIENCE TEXTS

Numerical Value		
100		I. Mechanical Make-up
15		A. Appearance and color of binding, including cover design
25		B. Durability of binding
15		C. Quality, finish and color of paper
20		D. Size, clearness and attractiveness of page
	10	1. Length of line
	5	2. Width of margins
	5	3. Footnotes
15		E. Size, clearness and attractiveness of type
10		F. Size and shape of book (convenient)
500		II. Subject matter
150		A. Objectives
	150	1. Harmony with objectives of course of study
250		B. Organization
	50	1. Organized around significant problems
	100	2. Organized throughout from psychological viewpoint
	35	3. Unit organization
	15	4. Flexibility, allowing for omission without destroying sequence
	50	5. Based on environment, interests and activities of pupils
100		C. Content
	25	1. Ease of comprehension
		a. Vocabulary adjusted to pupil
		b. Concise, clear literary style
	50	2. Value
		a. Material adapted to age and grade of average pupil
		b. Attention to pupil interest and motivation
		c. Interesting
		d. Practical applications
	25	3. Scope
		a. Essential topics included
400		III. Method
200		A. Psychological soundness
	45	1. Material adapted to age and grade of average pupil
	60	2. Provision made for individual differences through problems and projects
	30	3. Variety in types of activities
	25	4. Opportunity to develop general principles
	40	5. Attention to pupil interest and motivation
200		B. Aids to instruction
	20	1. Purpose or objectives stated in preface or introduction
	30	2. Laboratory exercises
		a. Sufficient in number and meaningful to pupil
		b. Developed in problematic form
		c. Practical applications
	20	3. Study exercises and testing devices
	20	4. Index
	10	5. Table of contents
	20	6. References and bibliography
	30	7. Pronouncing glossary
	50	8. Illustrations
		a. Adequate in size
		b. Adequate in quality
		(1) Well contrasted
		(2) Clear, focusing attention on parts author wishes to stress
		(3) Distinctive and artistic
		c. Legends used as learning devices
		d. Aid pupil in understanding concept presented
		e. Maps, graphs, diagrams
1000		Total

A DETERMINATION OF PRINCIPLES DESIRABLE FOR A COURSE OF GENERAL SCIENCE AT THE JUNIOR HIGH SCHOOL LEVEL. [I] *

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STATEMENT OF THE PROBLEM

THE purpose of the first part of the investigation is to determine the relative importance of principles of science which are desirable for inclusion in a general science course at the junior high school level.

DEFINITION OF TERMS

The following definitions of terms were used in this part of the investigation:

A scientific principle is defined in terms of four criteria: [2]

A. To be a principle a statement must be a comprehensive generalization describing some fundamental process, constant mode of behavior, or property relating to natural phenomena.

B. It must be true without exception within limits specifically stated.

C. It must be capable of illustration.

D. It must not be a definition.

A "course of general science" is a generalized course which includes subject-matter from physics, biology, chemistry, astronomy, and geology, and is designed to fit the needs of children at the junior high school level. Such a course is contributory to the development of an understanding of principles of science.

The term "junior high school" as used in this study means grades 7, 8, and 9 in the secondary school system of this country, regardless of any division that any specific school system might make between any two of these grades.

TECHNIQUE USED TO COMPILE A LIST OF PRINCIPLES

From lists compiled by Wise [3], Martin [4] and Caldwell and Curtis [5] all principles were selected which, in the opinion of the investigator, could possibly be used at the junior high school level. This list was refined by eliminating repetitious statements and was consequently reduced to 304 principles.

Keeslar [6] presents substantial evidence from five research studies which indicates that individual evaluations by a jury of as few as three individuals are both reliable and valid, within their frame of reference,

> . . . providing that (1) that the judges are well trained and experienced, i.e., experts in their field of specialization, and (2) that the criteria in terms of which the judgments are to be made be clearly and concisely stated for the purpose.

It was assumed, on the strength of these findings, that four evaluators would be sufficient to determine the desirability and the relative importance of principles and experiments for a course in general science.

The copy of the list of principles was sent to each of the evaluators, men well qualified and experienced in the general science field, with a letter outlining the problems and defining the terms "principle" and "junior high school" as they have been defined above. There was also written in the letter detailed instructions as to how to mark the principles. These directions indicated that each principle was to be rated on a three point scale: a highly desirable principle was to be marked +3, a desirable principle +2, and an undesirable principle was to be marked —2.

When the lists of principles had been evaluated and returned, the marks received by each principle were tabulated and added so that one mark indicated the importance of the principle as it was judged by the four evaluators. Hence a principle deemed highly desirable by all the evaluators re-

* Based on one phase of the author's dissertation for the degree of Doctor of Philosophy, University of Michigan, 1950. Part II will be published in *Science Education* at a later date.

ceived a total mark of $+12$; one less desirable received a lesser mark and so on until a principle considered undesirable by all the evaluators received a mark of -8. For example, the principle "Sound travels only through matter" received a mark of $+3$ from each evaluator and so received a total mark of $+12$; the principle "The range of life activities is narrow" received positive marks of 2, 2, 3, and 3, and hence had a total mark of $+10$. On the other hand, the principle "The life story of the individual tends to recapitulate the history of the race" received one mark of $+3$ and three of -2 and so was assigned a total mark of -3. The principles which did not receive a total positive mark were considered undesirable for a course in general science at the junior high school level.

Table I presents, in descending order of relative importance, the 118 most highly desirable principles of the 253 deemed by the judges to be desirable for a course in general science at the junior high level.

TABLE I

PRINCIPLES DESIRABLE IN A GENERAL SCIENCE COURSE AND THE TOTAL MARKS ASSIGNED TO THEM BY FOUR EVALUATORS

	Principles	Total Marks of Evaluators
1.	All matter exists as a liquid, a solid, or a gas.*	12
2.	Every body has weight and occupies space.	12
3.	All matter is made up of small particles called molecules.	12
4.	A gas tends to expand so as to fill all the space available.	12
5.	Warm water is forced up by the settling of cold water.	12
6.	In general, bodies expand when heated and contract when cooled.	12
7.	Water in nature is never pure.	12
8.	Every combustible substance has a kindling temperature which may be greater or less than that of another substance.	12
9.	Heat is conducted from one molecule to another by the transfer of kinetic energy.	12
10.	Heat is liberated when a gas is compressed and is absorbed when it expands.	12
11.	Evaporation and precipitation tend to follow each other in a cyclic order.	12
12.	The atmosphere of the earth retards the loss of heat from the earth's surface.	12
13.	When air is cooled sufficiently, the moisture in it condenses.	12
14.	Differences in temperature cause differences in atmospheric pressure and differences in atmospheric pressure cause winds or other air currents.	12
15.	The quantity of water vapor which the air can hold increases as the temperature increases.	12
16.	Atmospheric pressure decreases as altitude increases.	12
17.	Energy is often transmitted in the form of waves.	12
18.	When a wave strikes a surface, part of it is reflected.	12
19.	If a beam of light falls on an irregular surface the light is reflected in all directions.	12
20.	When waves strike an object they may be absorbed, transmitted, or reflected.	12
21.	When light rays are absorbed some of the absorbed light energy is transferred into heat energy.	12
22.	The more nearly vertical the rays of radiant energy, the greater is the number that will fall on a given horizontal area and the greater the amount of energy that will be received by that area.	12
23.	Whenever an opaque object intercepts radiant energy, a shadow is cast by the the object.	12
24.	The color of an opaque object is determined by the wave lengths of the light rays it reflects.	12
25.	Sound travels only through matter.	12
26.	Sounds are produced by vibrating bodies.	12
27.	Regular vibrations produce musical sounds; irregular sounds produce unmusical sounds (noise).	12
28.	The sun is the source of almost all the available energy on the earth.	12
29.	Movements of all the bodies of the solar system are due to gravitational attraction.	12
30.	Since the earth rotates from west to east, the exact time at which the sun is	

* This item is to be interpreted thus: The principle "All matter exists as a liquid, a solid, or a gas" received a total mark of 12 indicating it was judged highly desirable by all four evaluators.

nearest overhead grows continually later as one travels westward around the world. 12
31. The surface of the earth is always changing. 12
32. Running water, wind, glaciers, and other agencies are constantly moving land from higher to lower levels. 12
33. The earth's surface is raised in some locations and lowered in others by interior forces. 12
34. Rocks may be metamorphosed, or changed, by heat, pressure, or flexion. 12
35. Forces within the earth may cause breaks to appear in the earth's surface. 12
36. All plant and animal life is directly or indirectly dependent on the soil. 12
37. Only topsoil can hold the water and supply the minerals necessary for the life of most plants. 12
38. Various kinds of soil, and various depths of soils, contain different amounts of humus. 12
39. The work obtained from a simple machine is always equal to the work put into it less the work expended in overcoming friction. 12
40. Friction is present whenever work is done. 12
41. A magnet has at least two poles and is surrounded by a magnetic field. 12
42. Like magnetic poles repel; unlike poles attract. 12
43. Electricity may be produced by friction, by chemical action, or by the use of magnets. 12
44. Whenever electricity passes through a conductor some of the electrical energy is changed to heat energy and some may be changed to light energy. 12
45. Like electrical charges repel; unlike charges attract. 12
46. All materials offer some resistance to electrical currents and some of the energy used in overcoming this resistance is transformed into heat energy. 12
47. In an uncharged body there are as many protons as electrons and the charges neutralize each other; a deficiency of electrons produces a plus charge and an excess of electrons produces a negative charge. 12
48. No two living things are exactly alike. 12
49. All life comes from preceding life. 12
50. Every living thing dies but life continues. 12
51. Living things exist in all forms from simple to complex. 12
52. The fundamental life processes are the same in all organisms. 12
53. All living things carry on processes of reproduction, growth, nutrition, respiration and excretion, and possess irritability. 12
54. Forms of life other than those now on the earth have existed in the past. 12
55. Every living thing is composed of one or more cells. 12
56. The cell is the unit of function as well as of structure. 12
57. Growth and repair are fundamental activities of all protoplasm. 12
58. Protoplasm is built by protoplasm and cells by cells. 12
59. Every species has enemies and the species survive whose individual members are able to escape their enemies or are able to live in spite of them. 12
60. All living things require energy in the form of food. 12
61. Every living cell is able to take in food and get rid of waste. 12
62. All living cells require oxygen in the utilization of their food to obtain energy and to build protoplasm. 12
63. As long as life continues in an organism, energy is released. 12
64. Environment causes changes in living things and living things cause changes in environment. 12
65. Organisms which cannot adjust themselves to the environment lose the struggle for survival. 12
66. The energy which makes possible the activity of most living things comes originally from the sun and results from the oxidation of food in the body. 12
67. Light and heat from the sun are essential to the life of most plants. 12
68. Water is essential to green plants. 12
69. The oxygen that is free in air and water supplies the respiratory needs of living things. 12
70. The carbon dioxide that is released by animals and plants forms part of the supply of carbon dioxide that is used by plants as one of the raw materials for photosynthesis. 12
71. The oxygen of the atmosphere is removed by animals and plants and restored by the chlorophyll-bearing plants. 12
72. Certain optimal conditions of temperature, moisture, and light are essential to most organisms. 12
73. Water is an essential raw material in the manufacture of food by plants. 12

74.	Carbohydrates, fats, and proteins are produced by plants and animals which use them to provide energy and to build protoplasm.	12
75.	Micro-organisms which cause communicable diseases often go from person to person through the air.	12
76.	Energy can be transferred from one sort to another with exact equivalence.	11
77.	The materials forming one or more substances may be changed into one or more other substances measurably different.	11
78.	Matter may be formed into energy or energy into matter but the sum total of the energy and matter in the universe remains the same.	11
79.	A body immersed or floating in a liquid is buoyed up by a force equal to the weight of the liquid displaced.	11
80.	A floating body displaces its weight of the liquid in which it floats.	11
81.	A fluid moves from points of greater pressure to points of lower pressure.	11
82.	The pressure at any point in a fluid at rest is the same in all directions.	11
83.	The quantity of energy radiated from a body increases as the temperature of the body increases.	11
84.	Every pure liquid has its own freezing and boiling point.	11
85.	Under identical conditions, bodies of land heat and cool more rapidly than do bodies of water.	11
86.	Sunlight is composed of several colors and may be dispersed by a prism into a spectrum containing these colors.	11
87.	Dark, rough, or unpolished surfaces absorb light and radiant heat more rapidly than do light colored, smooth, and polished surfaces.	11
88.	In a medium of uniform optical density, light travels in straight lines.	11
89.	The color of a translucent object is determined by the wave lengths of the light rays it transmits.	11
90.	When a light ray strikes an object so that part of the light is reflected, the angle of incidence is equal to the angle of reflection.	11
91.	The natural movements of air, water, and solids on the earth are due to gravity and to the rotation of the earth.	11
92.	The energy of solar radiations is continually working changes in the surface of the earth and in its atmosphere.	11
93.	Original materials for the development of soils are formed through the disintegration of rocks.	11
94.	Certain rocks are formed by the cooling and soldifying of molten materials.	11
95.	Certain rocks are formed by the cementing and compacting of sediments.	11
96.	Many earthquakes are caused by the sudden slipping of earth along a fault.	11
97.	With the inclined plane the weight moved times the height through which it is moved is equal to the acting force times the length of the plane provided that friction is neglected and that the force is parallel to the plane.	11
98.	Every embryo begins life as a single fertilized egg.	11
99.	Growth is essentially the growth and multiplication of cells.	11
100.	A character is determined, not by a gene, but by a pair or pairs of genes.	11
101.	In multicellular organisms, cells are organized into tissues, tissues into organs, and organs into systems.	11
102.	Throughout life there is a building up and tearing down of protoplasm.	11
103.	By means of the sun's energy inorganic matter is transformed into plant and animal tissue and this tissue, in turn, is transformed into soil and air.	11
104.	All elements in living matter are found in its environment.	11
105.	Proteins are essential to all plants and animals.	11
106.	A balance in life is maintained through interrelationships between plants and animals.	11
107.	Each organism must have certain materials for life and whatever essential ones it cannot build it must acquire.	11
108.	Within the bodies of plants and animals, water and substances in solution pass by osmosis through membranes.	11
109.	In most plants and animals, sexual reproduction is accomplished by the union of a male and a female cell during fertilization.	11
110.	Living things produce more individuals than the environment can support, and hence the individuals must compete for the available energy.	11
111.	The flow of blood in the higher animals is circulatory in a closed system.	11
112.	The colors of certain animals serve to conceal them, to distinguish them, or to make them conspicuous in ways that aid survival.	11
113.	Life and protoplasm remain associated in a cell unless accident occurs, disease strikes, or poison enters.	11
114.	All forms of life are constantly exposed to attacks by microorganisms.	11

115.	Infection is possible when (a) there is an appropriate avenue to the host, (b) the infecting organism is present in the host in sufficient numbers, (c) the infecting organism is virulent, (d) the host is receptive.	11
116.	Disease germs may be transmitted through food and water, by contact, by biting-insects, and by carriers.	11
117.	For each disease a specific microbe exists.	11
118.	The body manufactures antibodies which immunize it against specific diseases.	11

SUMMARY OF THE EVALUATIONS OF 302 PRINCIPLES FOR A GENERAL SCIENCE COURSE AT THE JUNIOR HIGH SCHOOL LEVEL

It was found, from the judgments of four evaluators, that 253 of the 302 principles were desirable for a course in general science at the junior high school level. Of these, 75 were considered highly desirable by all of the evaluators. The marks allocated to the principles are shown in Table II. A high mark indicates a desirable principle, while a low mark indicates that a principle is less desirable.

TABLE II

THE NUMBERS OF PRINCIPLES TO WHICH THE EVALUATORS ASSIGNED THE TOTAL MARKS INDICATED

Number of Principles	Marks Assigned
75	12
43	11
25	10
7	9
2	8
18	7
24	6
22	5
2	4
1	3
12	2
22	1
Total 253	

inversely with the cross section of the conductor" was judged to be more appropriate for a physics, rather than a general science, course. Another principle, "Germ plasma passes on from one generation to another," is not capable of illustration and seems beyond the comprehension of junior high school pupils, it seemed to one evaluator. The other criticisms adverse to the principles were minor; the two illustrated, the difficulty of comprehension and the difficulty of illustration, indicated the major causes of failure on the part of the principles to receive a high rating.

The 253 principles, which were judged desirable by the evaluators, were classified by the investigator as to whether they were principles of physical science or biological science; and, furthermore, within the physical sciences, whether they were principles related most closely to physics, to geology, or to chemistry. This classification is in Table III.

In the physical science group (Table III) there are included all the principles which deal with physical phenomena. The determination as to whether a principle more appropriately is termed a principle of physics or of chemistry was done arbitrarily. As no principle was included in two fields of science, although many apply in more than one field, there may appear to be fewer principles listed in any one field than may be found if the whole list is analyzed for the purpose of finding principles suitable to that field. There is no

TABLE III

NUMBERS OF PRINCIPLES OF PHYSICAL SCIENCE AND OF PRINCIPLES OF BIOLOGICAL SCIENCE

Physical Science				Biological Science	
Physics	Geology	Chemistry	Total	Biology	Total
109	21	11	141	112	112

Many of the principles with the lowest ratings were considered by the judges to be more suitable for advanced courses in science rather than for general science. The principle "The resistance of a conductor varies directly with the length and

mention of the field of astronomy although several principles, e.g., "Whenever an opaque object intercepts radiant energy, a shadow is cast," certainly apply in this area of science.

To the extent that the techniques employed in the determination and evaluation of these principles may be acceptable, the following conclusions from this study seem justified:

1. Since 253 of the 302 principles submitted were deemed desirable for inclusion in a course of general science, it is obvious that there is an abundance of principles suitable for such a course.

2. Of the 253 principles accepted as desirable, 141 were principles of physical science and 112 were principles of biological science (Table III). From this finding it is evident that many offerings from both of the fields of science should constitute the general science course.

REFERENCES

1. Smith, Herbert F. A. "A Determination of Principles and Experiments Desirable for a Course of General Science at the Junior High School Level." Unpublished Doctor's dissertation, University of Michigan, 1950. Pp. vi+207. (Available through inter-library loan from University of Michigan Library; distributed in microfilm form by University Microfilm, Ann Arbor, Michigan.)

2. Wise, Harold E. "A Determination of the Relative Importance of Principles of Physical Science for General Education," p. 18. Unpublished Doctor's dissertation, University of Michigan, 1941.

3. Ibid., pp. 347–364, 742.

4. Martin, William Edgar. "A Determination of the Principles of the Biological Sciences of Importance for General Education." Unpublished Dictor's dissertation, University of Michigan, 1944.

5. Caldwell, Otis W., and Curtis, Francis D. *Everyday Science,* pp. 610–611. Boston: Ginn and Company, 1946.

6. Keeslar, Oreon Pierre. "Contributions of Instructional Films to the Teaching of High School Science," pp. 104–115. Unpublished Doctor's dissertation, University of Michigan, 1945.

SCIENCE FICTION FOR SCIENCE STUDENTS

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EVEN though they have been published for more than a hundred years, science fiction stories have risen in popularity enormously since the end of the last war. In addition to appearing in special pulp magazine form, they appear in bound novels, comic books and as short stories in periodical magazines. Thousands of readers belong to local and nation wide fan clubs. The popularity of this type of narrative is evidenced by the number of recent productions from Hollywood and the many radio and television programs on our national networks.

The influence of this type of narrative upon its readers, especially juveniles, should not be ignored by the science teacher. The popularity and abundance of this fiction not only has some good possibilities but also can have a very detrimental influence on science classes. Ordinarily the mention of a pulp magazine as having possibilities in an educational program may seem a little far fetched at first. Not handled properly this could be true. Science fiction for many years was considered sometimes to be very poor, low grade literature. If this is the case, many of our foremost scientists should be informed of their inferior tastes. An inspection of some scientific and educational journals will show that science fiction has invaded suggested literature in the book reviews.

Much of our early science fiction was written by some of our most respected authors, Wells, Verne, Poe and London. Many early science fiction stories in pulp magazines were based on plots by these men or were actual reprints. Today it is not uncommon to read a science fiction story appearing in a pulp magazine that was written by a respected scientist or a science student working on his doctorate.

Much of the literature on our Science room and school library shelves consists of textbooks, reference (specialized) books,

encyclopedias and nature stories. Occasionally one may find the experiences of some of our modern explorers and scientists written for public consumption but as a rule they are not too popular with children probably because of the style and vocabulary. Many "science" books in narrative form are usually woven about a few children performing some experiments. Narrated science lectures are very common. Some can hardly be distinguished from the ordinary textbook if the first and last chapter are omitted. Frequently it is a "story" of some life history narrated to some imaginary listeners. In the less desirable types, even the animal may narrate his autobiography or an adventure. There are, however, several fairly good biographies of scientists and some acceptable "career" novels. It is quite evident that the narrative method is used as a "sugar-coating" for the child to acquire his science. If this is acceptable to our school libraries and science teachers, there should be little objection to the narrative style itself.

The important consideration must be the science presented in the story. This must be kept in mind when judging science fiction stories for children.

Most science teachers know how popular the study of astronomy is with children especially when the possibilities of life on other planets is explored. The story of "Flying Saucers" over the radio and press has stirred the imagination of all. The news of progress made in the study of atomic energy and fast transportation encourages the hopes and philosophies of the average reader. It fires their imaginations. With proper direction and influence, the science teacher can well take advantage of this enthusiasm for fantasy in his students.

There are probably both good and bad points about almost anything that is written. When literature is published for light reading and quick sale it must be examined very carefully if it is to be used with young minds. In a study being made of science fiction publications (which are available to children, although not necessarily written for them), there were several objectionable items found, viz.:

(a) Most science fiction magazines had inferior bindings and poor quality paper.
(b) Little true science was present, very few facts, no scientific methods and few principles were used.
(c) There were many half truths in addition to quasi science.
(d) Much of the vocabulary was not scientific. It was imaginary and not consistent. Most of it was limited to authors.
(e) Repetition of general plots was common.
(f) Astronomy and space travel were over emphasized.
(g) There was much "flashy" art in the illustrations.
(h) Excessive "love interest" at times was not suitable for children; too adult.
(i) Life appeared to be cheap with the death and destruction of "undesirable characters" too common.
(j) Cruelty, militarism and grotesqueness was emphasized (which may have a tendency to create fears and undesirable attitudes).

Every book made available to children, should be read very carefully by the teacher. If the children are to benefit at all in the way of science, the values they are to gain from reading the story must far outweigh any of its weak points. A science fiction story must be judged far more critically than any other narrative, for many obvious reasons. A fantasy story should not be chosen for its adventure or fantasy appeal alone, especially since science fiction stories usually are more adventure laden than most.

With the age group, comprehension and vocabulary of his students in mind, the science teacher should determine first, exactly what type of science fiction story he needs or wants. To get an excellent classification of the science fiction stories, Bailey's [1] work is one of the most comprehensive on the subject and readily available to all who frequent any metropolitan library. Some of the more general types revolve about forecasts, philosophy, invention, exploration and many varied combinations. After reading, the teacher should determine whether the story has anything worthwhile of scientific value, whether it

[1] Bailey, J. O. *Pilgrims Through Space and Time.* New York: Argus Books, 1947.

be facts, applications, phenomena, or philosophy. If the story or book has been judged worthwhile up to this point, the objectionable points such as those previously listed should be considered. Final analysis should revolve about considerations such as those used in judging any juvenile fiction.

In a recent study by the author, students who had read suitable stories, watched television shows or listened to science fiction radio programs appeared to benefit somewhat. The radio and television shows had few objectionable points. It was quite evident that there were values derived over a period of time. These devices which can be considered as audio-visual aids to science education should be considered in our programs along with other approved aids.

VALUES DERIVED

1. Develop the imagination and curiosity (useful as a source of inspiration).
2. Aid students in distinguishing fact from fiction.
3. Show the difference between possibility and probability.
4. Develop an open mind, see another point of view.
5. Show that times and events change.
6. Realize the social and spiritual implications of science and technology.
7. Appreciate scientists and scientific progress.
8. Develop critical, analytical thinking.
9. Prepare for future events and possibilities.
10. Show that science is not merely new gadgets and weird, secret activity.

In building a good collection of science fiction stories, there should be variety in the collection. At present, the most common stories available to children in the average library is centered about space travel and the exploration of planets. Another type, which at times might be considered as really historical science fiction is the anthropological stories of cave men. The latter is probably the most common science fiction narrative found in school libraries. The former are on the secondary level, especially the most recent publications.

An approved book should be made available to the students at all times and suggested to the students when the particular subject under study is apparent in the fictional narrative. They should never be required reading, but can be used as a supplement or can serve as an illustration of something special. Many serve well as a stimulus for future studies. They should not be used as a substitute for other scientific literature but could be encouraged as reading during science study periods and as light leisure reading.

In spite of all the science fiction written for public consumption in the last hundred years, there is a comparative lack of really good science fiction which is suitable or written especially for children. The quality of the material, however, is improving as is the variety or type of story to choose from. With the number of readers increasing it is very probable that the number and quality of stories available for young readers will increase.

Considering the potentialities of good science fiction, it might be well worthwhile to look into the possibility of increasing the amount of this type of literature on our library and science room shelves. If the regular science fiction authors do not fill our need, it might even be worth our while to encourage our scientists and science teachers to write the type of stories we need. Many of our noted scientists write adventure stories but usually most of them are for the adult reader and even though they are meant to be for the layman they have too many technical terms and details that are not appealing to our younger citizens. If scientists who have had exciting scientific adventures that would thrill the imagination of any young reader, do not satisfy our needs in children's literature, then we must depend upon the professional fiction writer to inspire and entertain the young reader as we do in other fields of fictional literature.

THE CORRELATION OF BIOLOGY AND ENGLISH

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BIOLOGY and English are required subjects for all tenth graders at Salem High School. Because the field of biology is rich in material and activities which lend themselves well to the teaching of certain English skills and because the sophomore text, The English Workshop, seemed well suited to such a correlation the teachers of the two subjects planned a course in which the work of the two classes was connected as closely as possible.

A careful study of the biology course of study and of the English textbook brought out the fact that there were many ways of developing the project. For instance, biology students, to become better acquainted with their environment take field trips where they must observe with discrimination and record with accuracy what is seen. The English text stresses purposeful curiosity and interest in scientific subjects. Biology students, to gain an appreciation of the contributions of scientists to our present modern living, find it necessary to make intelligent use of library facilities. This again is emphasized in the English text. And to make such information gained in the library available to all the class a student must be able to organize and give an interesting talk. Such skills are best developed under the able leadership of the English teacher. A frequent criticism of biology courses is the large vocabulary of unfamiliar scientific terms which confronts the students. An understanding of word building developed through the English classes would minimize this difficulty. Another excellent learning activity, dramatization, is seldom used since applicable plays or scripts are not available in biology. Here the English teacher can materially help by encouraging the composition of original plays based on exciting episodes in the lives of scientists. Diction, voice, selection and use of words may also be developed in the production of these plays for biology classes over the public address system.

In order to carry out such a correlation the principal arranged for a block class in English and biology. A group of 31 students was assigned to biology for period 2 and the same group proceeded to the English classroom for period 3. This group was to continue intact for the entire year. Selected at random from the 550 members of the sophomore class it consisted of 12 boys and 19 girls having a mean I.Q. of 105. The students were given pretests in biology, English fundamentals, and the use of the library at the beginning of the term and similar tests at the end of the year. The English and biology teachers planned the lessons together throughout the year yet taught separate classes in English and biology. Whenever feasible, assignments were made in biology which could be carried out in the English class. Biology students might be asked to write a description, make an interview, prepare a panel discussion, or write a play on the subject being studied and upon arriving in the English class find it extremely functional in preparing their biological classwork.

It is impossible to mention all the ways in which the classes were correlated but a description of a few of the assignments which proved popular with the students will give the reader an understanding of the way in which the project was carried out.

While studying the interesting life in a drop of pond water through the microscope the students were permitted to describe what was seen rather than make elaborate drawings. This gave them an opportunity to observe and record color and activities as well as shape and structure and a need for English skills as well. The resulting

descriptions were not only scientifically accurate but extremely entertaining. Some were even illustrated.

Another assignment which proved highly acceptable to students was on the use of the library. Both teachers believed that an early introduction to the library and its facilities was an essential part of the course so an assignment was made which required the use of the card catalog, the Readers' Guide, and the encyclopedias. Each student selected a subject of a biological nature in which he was extremely interested and then enlisted the help of the English teacher and the librarian in finding his material. In developing this assignment the students made a trip to the state library, prepared bibliographies for the English teacher, and planned an oral report for the biology class.

Later in the year, while studying vitamins in biology class, the students were divided into groups each of which was responsible for presenting to the class all the information possible on one vitamin. After much research in the library and many consultations with the English teacher on the best means of presenting their material the groups finally worked out radio scripts for presentation over the public address system. There, with chimes and sound effects, and all the excitement of a first audition, the plays were broadcast to an intent and interested audience back in the classroom. One of the plays was chosen and broadcast as part of the weekly school program over a local radio station.

Another way in which the two subjects were correlated was through the study of words. While the English teacher was developing the use of prefixes, suffixes, and stem words the biology teacher prepared two games in which the students applied their newly acquired English knowledge in digging out the meaning of scientific terms.

It was even found possible to correlate poetry and biology. While studying trees and forests in the biology class a recording of "Trees" by Joyce Kilmer was synchronized with Kodachromes of trees. Students were encouraged to read other poems on themes related to units under study, find suitable illustrations and present them to the class.

The reaction of the students to this type of block class was most gratifying. Over and over in the final evaluation students commented on the fact that the correlation made both subjects more interesting. Some of the statements made by the students were as follows:

> "Biology, my favorite subject, is made even more interesting when it is combined with English. This combination has helped me with my hardest subject—English."

> "English was always my favorite subject and I now feel more enthusiastic about biology. Writing and acting out plays, going on field trips, and writing themes and stories has made biology more interesting to me through English."

> "In English you learn about prefixes, stems, and suffixes. When you go to biology you are given the chance to put what you have learned into use. As you learn new words in biology it is actually fun to put prefixes to stems."

> "I have liked this school year very much with my biology and English classes combined. It has been a lot of fun and has made me like biology and English better than I ever thought I would. When the biology class went on a field trip we usually had to write about it in English class. It is much more interesting to write about a place you have actually been."

> "English has helped me make better outlines and written themes than I probably would have in biology."

All students but one felt that the advantages of a correlated English and biology class outweighed the disadvantages. That student wrote: "I like biology and English very much. I think biology is more interesting but I feel that English is more helpful than biology in the long run. Biology is a constant source of interesting facts and principles; English is a lifetime help for every field of life. I don't like the two subjects combined. Two such interesting and highly individual subjects should be given full consideration and time."

Both teachers were favorably impressed by the educational growth made by the 31 pupils, who developed initiative and resourcefulness, and an ability to handle oral work with ease. Results of final tests in

English, use of the library, and biology gave concrete evidence of the excellent progress made in all three fields. In the biology class different forms of the Cooperative Biology Test of the American Council on Education were used at the beginning and end of the year. On the pre-test the median percentile was approximately 8; on the final test the median percentile was 89.

Such results combined with the improved attitude and enthusiasm of an interested class made both teachers feel that the extra time and energy given the group had been most worthwhile.

SOCIETY CHALLENGES THE BIOLOGY TEACHER

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THE high school biology course today has an unparalleled function in the curriculum. Yet, too many of us are prone to act as if it were just another course to fill in a student's program. Whether our students perceive it or not, we as science teachers should know without qualification that an adequate scientific background is an essential in order to produce democratic citizens capable of intelligently directing our nation's affairs.

Of all teachers we are the ones who must cultivate a sense of civic responsibility in ourselves. In our vital field it is of supreme importance to plan our lessons so as to stress those features of our subject which will make our students better adjusted to life in 1951, not 1901. We are faced today with many problems that are peculiar to our times, or that have developed a new twist. Let's keep our science courses up to date and adjusted to the times!

There are at least six basic concepts which can be included in all biology courses to the benefit of the students individually and to society at large.

The first of these is the desired conduct of the individual in social groups. In a period of history in which mental maladjustment is so prevalent, it behooves the biology teacher to work out with his students some of the desirable and the undesirable habits which human beings show. Often individuals are completely unaware of the undesirability of some of the mental habits they possess. While recognition doesn't necessarily assure a reversal of habit, yet it is the first step towards forming a better one.

After determining with the students the desirable and undesirable habits humans possess, the author has found it a worthwhile experience for each student to critically review his undesirable habits, relate an incident in which he displayed each one, and suggest how he would respond if faced with the same situation again in the light of his new knowledge. The tenth grade students with whom this was tried showed a great deal of frank, honest, self-evaluation, with some students evincing a very mature viewpoint. These problems and their solutions were written in confidence to the teacher. The teacher then picked out some of the most common problems (e.g., jealousy of one's best friend, hatred of siblings) and concentrated discussions on these. In conjunction with this some of the fine motion pictures and books on improving personality were used.

In this connection, a second basic concept can be brought in: tolerance towards persons of differing races, religions, and nationalities. There are various methods of introducing and fashioning new viewpoints. Perhaps the least successful one with high school students is the point blank examination of the evils of intolerance. In a subject which is dominated more often by

emotions than by intellect, a more subtle approach can gradually change a student's viewpoint. A blunt castigation merely puts the student on the defensive for a point of view he himself, in all probability, never formulated.

By interjecting information pertinent to building up the desired attitude of tolerance throughout the semester, a gradual shift to the end sought for may be secured. Then in summary the students might be asked to piece together the information they have acquired (e.g., the fact that all four blood groups are found in all races, religions, and nationalities; the fact that all three races show some primitive and some advanced characteristics in the evolutionary process). From this summary our common stereotyped pictures of various races, religions, and nationalities can be exploded to advantage. Once again there are numerous fine films that can be secured in relation to this subject.

A question which invariably comes up concerns evolution. Though there are perhaps some areas in the United States which still prohibit teaching evolution, those of us who have no such restrictions are not excused thereby from developing this, the third basic concept.

A study of the dinosaurs offers a logical entrée for instilling the idea of change. As no one's emotions are entangled with these cumbersome beasts, evolution per sé may be introduced without a mental bloc immediately being formed against it. Making maps of the geographical changes throughout the geologic ages also aids in comprehending the constant state of flux found in the universe. If students, unconvinced that the world was really like this still remain, a plea can always be made to observe how a small niche with which they have been acquainted during their lifetimes has changed.

Learning how our universe is constantly changing is important in itself; however, when used as an introduction to eugenics both in plants and animals (and especially human beings), it becomes doubly important. The numerous examples of beneficial plant and animal breeding can be brought in on their own merit, though their real function should be to introduce the pros and cons of human eugenics. While such a discussion is taking place, the students should have firmly in mind that we are the only living beings that are faced with this particular problem of deciding who should or should not be allowed to reproduce his kind. We have altered the stocks of our domesticated plants and animals to our benefit. May we also alter the stock of human beings now on earth? Can we expect to progress forward while permitting persons mentally, morally, or physically unfit to reproduce at will? These and related problems will certainly be faced by our students in the future. If they are to decide intelligently the proper course of action, they need at least an introduction to the subject in our classes.

Along this same line we are obligated to stress a fifth concept: conservation of our mental as well as our natural resources. In regard to the former, we teachers can do our part in our own classrooms. So often we find ourselves letting the more intellectually capable students shift for themselves while we concentrate our efforts on the slower students. Yet, it is the former who are our greatest hope for the future. All of our political, social, and economic leaders passed through the high schools of America and they will continue to come from the ranks of those we teach today. Therefore, it is imperative that we encourage and aid our brighter individuals to work to their true capacities in a democratic atmosphere.

Also in this connection we can fulfill our social obligation by teaching some of the reasons for, and the types of mental maladjustments in people today. The mere knowledge that increasing numbers of persons are in mental institutions today because of mental disorders, should hasten the inclusion of this information in our courses.

Much more teaching has been done on

the second type of conservation: conservation of natural resources. While many of us have dutifully presented all of the facts, how many of us have tied up this information with the central reason for presenting it? Knowledge of the facts alone will not necessarily aid our country unless we dig back into history and evaluate the laws that worked to the detriment or to the benefit of conservation. If we can thus make our students aware of the fact that they are the ones who will make and break laws affecting conservation, we shall have completed our aim.

Lastly, and most difficult, a sixth concept must find its way into our lesson plans: how to apply scientific principles to our everyday political, economic and social problems. We may lecture as much as we wish, give as many tests as we wish, and yet we still cannot be guaranteed that our students will actually apply what they know with what they do. Though Americans have progressed further, perhaps, than other peoples in most fields, the fact remains that a significant number of ancient superstitions and general mis-information still occurs. Even more frequently, while the "spirit is willing, the body is weak." We may demonstrate in ten ways that alcohol is a poison when used inside the body; yet will our students' habits be governed accordingly? We may get our students to intellectually concede the equality of all men, but can we motivate them to apply that equality in laws affecting the lives of those men?

This is indeed our problem. Whether we like it or not, we, as teachers, are leaders in our communities and primary agents in changing the attitude and behavior of countless individuals. Furthermore, we science teachers are the ones who have had extensive training in the field that has progressed furthest toward making the world a better place in which to live. Thus we are peculiarly equipped to bring scientific facts and methods into the lives of millions of Americans. Perhaps at no other time in the history of the world have teachers been faced with such a tremendous claim to their abilities. Though it is so easy to continue in the old ways, we must always remember that our very future as Americans hinges on the answer we give this challenge.

THE NEED FOR AN IMPROVED PROGRAM FOR TRAINING HIGH SCHOOL PHYSICS TEACHERS *

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This topic seems appropriate to this organization for three reasons:

1. The majority of our college physics students come from the public high schools. From a materialistic point of view, if we increase the high school enrollment in physics, it could lead to a greater enrollment in college physics. Of course, this is not guaranteed, for it is possible to visualize that a student's experience in a high school physics course could result in lessening rather than increasing his desire to pursue further studies in this field. A big factor in determining the outcome is the *teacher*.

2. It is in our classes that prospective high school physics teachers receive their training.

3. There is a great need for improving our program of training high school physics teachers: someone, some interested body, must step forward and assume the leadership. It seems to me to be entirely appropriate that this organization could rightfully assume such a responsibility.

* Paper presented at meeting of the Western Pennsylvania Section of the American Association of Physics Teachers, May 13, 1950.

To point up the great need for improving our program of training high school physics teachers, let me first briefly review a part of the certification law of Pennsylvania. A student may go into the public schools of Pennsylvania and teach physics if he has completed as little as *3* hours of college physics, plus 12 hours of any science. This can be completed with even a "D" grade and still be acceptable! (Incidentally, *no* mathematics is required for certification.)

Within the last semester, one Pennsylvania educator asked me why we physicists had not been able to better sell our program to the public; and he quoted the low enrollment in high school physics classes as a proof. We must face the facts: the enrollment in high school physics *has* fallen off during the past 20 to 25 years, and even the impetus of World War II has not greatly changed the picture. Of course, there are many reasons for this trend, some of which are not directly attributable to physics or physics teaching themselves. But at the risk of being a heretic, I would like to suggest that perhaps we do not always have the goods to sell that the consumer wants or feels he needs. For example: a high school principal, and former physics teacher, told me of a friend who complained about the low enrollment in his high school physics classes. Upon further discussion, the friend produced his course of study and in the upper right-hand corner was typed the date *1911!* In all fairness, I should add that there had been some changes made in pencil. Now, it is true that Archimedes' principle and many other concepts are still valid after some 2000 years, but apparently more than validity is needed to satisfy the youngsters of 1950.

Perhaps some of us are not free from criticism. If we compute a ratio of enrollment in first year college physics to the numbers that elect further courses, the fractions is not too flattering. Is this situation to be expected, or somewhere along the line are we "missing the boat"?

I am not so sure that it would be wise to have separate and radically different first-year college physics courses for the prospective electrical engineer, the mechanical engineer, the medical students, the research physicists, the chemist, the high school and college physics teacher, the general student, etc. But, on the other hand, it does not seem to me to be advantageous to herd all students into a single course and attempt to feed them all the same elixir. Do we throw all students in the same courses, expecting each to discriminate, evaluate and finally synthesize the material into a meaningful and useful source peculiar to his own needs? That is expecting quite a bit from the student.

There is a place for the rigorously mathematical physics for the future physicist and engineer, but it seems inappropriate to expect all to enjoy and profit equally from such a course—and I would place future high school physics teachers in the excepted group. To put the issue squarely and frankly, as I see it, many of us, including myself, are afraid that our courses will be accused of being not "academically respectable." But is a physics course appropriate to developing research physicists equally suitable for training high school teachers? Some colleges are operating a 3 or 6-hour credit first-year physics course designed for high school teachers. I believe this is a step in the right direction, but it is not enough in the preparation for high school physics teachers.

If I may be so presumptuous, I would like to briefly describe some of the ideas we are experimenting with at the State Teachers College, Indiana, Pa.; certainly not with the thought that they are unique or that they should be models, but rather as possible suggestions that may have some merit for consideration.

Like other colleges, we must work within the framework of required curricula. Also, graduation requirements set a minimum of 24 hour sequence of courses in physics for a "major" and 18 hours for a "minor." Further, there are 13 titles of physics courses indicated locally that are acceptable for accreditation, from which a student is

programmed. Although these conditions may sound rather restricting, actually there is considerable latitude allowed in developing the individual courses, as well as the whole program of training in physics.

On paper, a typical student's program sounds quite traditional, i.e., a first-year course in physics, followed by advanced courses up to a minimum of 24 hours for a major and 18 hours for a minor. To give some indication of the level of difficulty of these courses, we use as a textbook in the first year, *College Technical Physics* by Weber, White, and Manning; and for the advanced courses, *Foundations of Modern Physics* by Brown, in the Modern Physics Course) and the series of three books, *Principles of Physics* by Sears. I think you will agree that these texts are "academically respectable."

We stress individual laboratory experiments; each course carries required laboratory work. A student majoring in physics completes about 120 individual experiments during his college career.

Since our primary objective at Indiana is the preparation of teachers, we have no qualms about interrupting a class or laboratory period to discuss such questions as, "Is this topic appropriate to high school students? What would be a good way to develop an understanding of this concept? Would it be advisable to purchase this type of equipment for a high school? How can I demonstrate this principle with 5 and 10-cent-store equipment?" We have a regular laboratory techniques and method course, but we do not wait until then to discuss questions such as these. They are a part of each course.

The testing program conceived by a teacher often is a factor in selection and emphasis of the course materials; certainly it is accepted by most students as representing the evaluation of the most desired outcomes. Therefore, we attempt to aid our students in developing a testing program in physics that measures more than memorization of facts. One way that we do this is by example; we have and are developing a series of tests calling for the demonstration of such abilities as application of principles, interpretation of data, and recognition of facts vs. assumptions and their relevance to an argument. These tests are administered and discussed in our physics classes.

In each course beyond the first year physics, a student compiles a "Source Unit" in that area, such as electricity and magnetism, appropriate to the high school level. This unit contains such headings as

Suggesting Teaching Approaches
Unit Outline
Student Activities
Laboratory Experiments
Demonstrations
Equipment—Films
Unit Test

These sections are filled in rather completely. For example, under "Equipment" the student assumes his prospective school has no equipment in physics and that he does have an appropriation of so much money. He then makes out a regular equipment order. Of course, this brings up the whole problem of selection and purchasing, as well as improvisation of equipment. Discussions are held, and guidance given in completing his work, but the decisions on what to include or exclude in the order are left to the student. This is equally true of all the student's source unit: we try to avoid setting up any one pattern as "best."

These source units should not be thought of only as preparation to teach in the future; the students gain considerable insight into the subject of physics by constructing unit outlines and tests, closely examining equipment catalogues, etc. To help the student in preparing his source unit, we have accumulated copies of all the high school physics texts and laboratory manuals currently on the market. This also provides an opportunity for him to evaluate these materials before he may be called on to order them for his school.

Also provided are individual copies of some 35 pamphlets published by firms such

as Westinghouse, General Electric, General Motors, etc. He may find these helpful in keeping in touch with the newer developments, and also he may take them with him to his new teaching position, to start his own library of materials for the high school youngsters.

We do not always restrict our ideas and materials to physics alone because we feel that prospective high school science teachers must have a broader training. For example, we discuss the sponsoring of a science club and what projects in physics would be appropriate for a high school science club. Materials relative to this topic are either collected by the individual or their source recorded for future reference. The students become acquainted with the Science Clubs of America and the potential use that this group may be to them when they become teachers. We also encourage our students to join The National Science Teachers Association and become familiar with this most helpful organization.

Another idea that we are trying this semester for the first time is school visitations. We are all familiar with high school groups visiting industrial plants, laboratories, etc. However, we felt a need to reverse the picture. For these visitations, each student majoring or minoring in physics at Indiana prepares a demonstration appropriate to the high school level, and in the majority of cases, something different from what most high school youngsters would have seen before. The demonstrations are presented before the high school physics classes in their own laboratories. These visitations give our students an opportunity to do a little teaching but principally it allows them to see typical high school laboratories and equipment, and to learn generally the teaching load and responsibilities of a high school physics teacher.

A student's training at Indiana is culminated in a semester of full-time student teaching in one of the many cooperating high schools. He will not devote all of his time to teaching physics, but in addition, he will usually teach such courses as physical science and/or general science. Here he will have an opportunity to use such materials as the source units he has prepared and to revise them before starting out on his own.

Another contact with high school students and their work is provided when the Science Club of Indiana State Teachers College sponsors an annual science fair for the surrounding high schools.

This paper has been limited to the preparation of teachers for high school *physics* since it is with this phase of science that this organization is most concerned. However, we must realize that the majority of our high school physics teachers will be called upon to teach other sciences, usually chemistry and/or general science, or to teach mathematics. Incidentally, a tabulation shows that when a high school science teacher in Pennsylvania is called upon to teach some subject outside of science, in about 50 per cent of the cases the other subject is mathematics. This percentage is probably even higher if we considered only physics teachers. Any teacher-training program must then be consistent with the realistic problem of certifying and qualifying the teacher in some field or fields other than physics.

Another aspect of teacher training that I feel we have neglected is in graduate work. If a student follows a curriculum such as we have at Indiana, he is not qualified to start right in a graduate program in physics, as is usually taught in the universities today: nor would such a program be appropriate to his needs. The acquisition of a Masters Degree is becoming more and more desirable for high school teachers and if we cannot provide suitable outlets for these teachers, they are forced into other fields. One possibility that is being adopted by some universities is a "physical science" program consisting principally of physics and chemistry courses. We need more such efforts to provide ambitious high school teachers a means to further study. But again, I would not agree that our high school science teachers should be thrown

into the melting pot of our advanced classes and expected to receive maximum benefits.

You are undoubtedly familiar with the Science Fellowships offered by Westinghouse and General Electric during the summer for high school science teachers. I have not had the privilege of seeing the programs in operation, but from the description of the courses and activities it would seem that they come closer to meeting the needs of many high school physics teachers than do some of our courses. If this be true, should we not immediately investigate the potentialities of similar programs for our colleges and universities?

In conclusion may I respectfully suggest to this organization some of the needs that are crying for leadership.

1. We need a review of the present certification requirements in the public schools of Pennsylvania and perhaps other states.

2. We need an overall study of what constitutes good teacher preparation for high school physics. I think we all recognize the ideas that we are trying at Indiana are only stop-gaps. We need a broader basis of planning and operation.

3. We need specific recommendations to come forth from point two. We cannot talk in generalities and expect to sell our program.

4. We college physics teachers need to realize that a "straight" course in physics may not be equally valuable to the prospective research physicist and the high school physics teacher.

5. We need a program of graduate studies for high school physics teachers that will be within their comprehension and that will really be of value to them as high school teachers.

6. We need to know more about the job we ostensibly are training students to do. We need to get out into the local high schools and see what problems exist; talk with the students, teachers, and principals. We cannot fully appreciate the problem of equipment, for example, until we actually hold the schools' entire supply in the palms of our two hands (which is not impossible in all too many cases).

7. We need to teach, and to prepare our students to teach physics in 1950, not in 1911 (including the pencil revisions).

8. *We need an improved program for the training of high school physics teachers.*

A PILOT STUDY OF VARIOUS METHODS OF TEACHING BIOLOGY

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THE PROBLEM

This pilot study was undertaken in an attempt to discover the relative value of various multi-sensory methods in the teaching of high school biology.

THE SAMPLE

Eight Kansas high schools in second and third class cities were selected to take part in the experiment. In all, 192 students were enrolled in the eight classes.

THE METHODS

These eight schools were divided into four groups of two schools each. These groups used the following methods of instruction:

C. The Control Group.

This group was instructed in the traditional

textbook fashion. There was a minimum of laboratory work and only a few demonstrations were completed. This group saw no instructional films during the year.

F. The Film Group.

This group studied eighteen of the most appropriate instructional films that could be procured from the University of Kanses Bureau of Visual Instruction. These films were used to supplement the textbook materials. No laboratory materials were used and demonstrations were kept at a minimum.

L. The Laboratory Group

This group was furnished with various materials for dissection and examination in the laboratory. Perch, frogs, starfish, clams, crayfish, grasshoppers, and earthworms were provided for these students. No instruction films were used in these two schools.

F.L. The Film and Laboratory Group.

This group had the benefit of both laboratory materials and instructional films. The materials furnished to group F and to group L were provided for these schools in order to determine whether or not a combination of multi-sensory materials would be more effective than one type alone.

TESTS ADMINISTERED

The students who participated in the study were given the *California Test of Mental Maturity* and the *Minnesota State Board Examination in Biology,* 1947.[1] These tests were administered during the first week of school in the fall of 1950.

The biology test was constructed to test four areas: factual information, understanding and application of biological principles, understanding and application of the elements of the scientific method in biological situations, and scientific attitudes.

The biology test was administered to these students again during the last week of school in May of 1951. It was felt that this time lapse of nine months between first and final exposure to the test would eliminate the necessity for using two different forms of the test.

The test used to measure learning during the school year possessed high validity and reliability.[2]

STATISTICAL ANALYSIS

The statistical technique used to compare the outcomes of the four teaching methods is known as analysis of variance and covariance. This technique permits the comparison of two or more groups at a time, holding two or more variables constant.

The assumptions basic to pooling schools into groups for purposes of analysis are: (1) homogeneity of means and (2) homogeneity of standard deviations. These assumptions were met at the .01 or the .05 level.

The assumptions basic to the technique of variance and covariance are: (1) homogeneity of variance and (2) homogeneity of within partial regression coefficients. These assumptions were met at either the .01 or the .05 level.

Skewness and kurtosis were calculated for the distributions of intelligence test scores, pre-test scores, and post-test scores. This data, as well as histograms which were constructed, indicated that the distributions were unimodal and differed only slightly from normality. Fisher[3] has shown that the efficiency of the statistical analysis remains reasonably high, even though a distribution departs moderately from the normal distribution.

Intelligence test scores and pre-test scores were held constant by using the technique of analysis of variance and covariance. The value of F was found to be 27.05 (Table I). Entering Snedecor's table of F with $n_1=3$ degrees of freedom and $n_2=186$ degrees of freedom, we found that the value of 27.05 was significant. It was therefore concluded that there was a

[1] Prepared for the State of Minnesota by Kenneth E. Anderson, School of Education, University of Kansas.

[2] Kenneth E. Anderson, "A Frontal Attack on the Basic Problem in Evaluation: The Achievement of the Objectives of Instruction in Specific Areas," *Journal of Experimental Education,* XVIII (March, 1950), pp. 163–174.

[3] R. A. Fisher, "On the Mathematical Foundations of Theoretical Statistics," *Philosophical Transactions of the Royal Society of London,* A, 222 (1922), pp. 309–368.

TABLE I

ANALYSIS OF VARIANCE AND COVARIANCE OF FINAL SCORE WITH INTELLIGENCE TEST SCORES AND PRE-TEST SCORES CONSTANT

Source of Variation	d.f.	Sum of Squares	Mean Square	F	Hypothesis
Within	186	5495	29.54	27.05	Rejected $P<.01$
Between	3	2397	799.00		
Total	189	7892			

significant difference between the four groups in the study.

In order to determine which of the four groups achieved the most during the year, holding intelligence test scores and pre-test scores constant, adjusted means were calculated for each group (Table II). This was done by adding or subtracting a correction factor from the final mean.

In order to determine the significance of the differences between the adjusted means, it is necessary to run $\frac{4\times 3}{2}$ or six "t" tests. The required probability for the selected differences to be significant is not 1 in 100 but 1 in 6(100). Therefore, a "t" value to be considered significant should not have a probability value greater than about 8.3 in 1000 at the five per cent level or greater than about 1.6 in 1000 at the one per cent level. The table values of "t" and the adjusted values are shown in Table III.

CONCLUSIONS

The four groups in this study achieved different amounts when taught with different multi-sensory techniques. The students in the film and laboratory group achieved significantly more than the students in the control, film, and laboratory groups. The differences in mean achievement of the last three groups were not significant.

TABLE II

ADJUSTED MEANS

	Means			Diff. G.M.				corr.	corr.	Adj.
Group	CTMM	Pre	Final	CTMM	Pre	b_1	b_2	b_1	b_2	Means
C	98.29	43.36	47.86	3.37	—.06			.15	—.05	47.96
F	101.40	42.64	51.14	.26	.66	.04492	.90679	.01	.60	51.75
L	100.69	43.58	50.61	.97	—.28			.04	—.25	50.40
FL	105.85	43.55	57.43	—4.19	—.25			—.18	—.23	57.02
Grand Mean	101.66	43.30	51.88							

TABLE III

ADJUSTED VALUES OF "t"

Comparison	Adj. Means	t	Probability Value About	Probability	Hypothesis
C vs. F	C 47.96 F 51.75	2.19	28.6/1000	$P>.05$	Accepted
C vs. L	C 47.96 L 50.40	1.77	76.8/1000	$P>.05$	Accepted
C vs. FL	C 47.96 FL 57.02	5.67	.2/1000	$P<.01$	Rejected
L vs. F	L 50.40 F 51.75	.85	395.4/1000	$P>.05$	Accepted
L vs. FL	L 50.40 FL 57.02	3.72	.2/1000	$P<.01$	Rejected
F vs. FL	F 51.75 FL 57.02	2.84	4.6/1000	$.05>P>.01$	Rejected

This experiment was in the nature of a pilot study. Refinements in technique and better control over the activities of the participating classes would make for more conclusive results.

However, within the limitations imposed upon the findings it may be concluded that on the average, a combination of these aids will bring better results than aids of only one type.

The problem would seem to be of sufficient importance to warrant further investigation on a larger scale.

INTRODUCING THE CONTRIBUTORS

(Continued from page 236)

of one textbook (*Science For Better Living,* two others are ready for press) one laboratory manual, a chapter in a forthcoming book, *The Wild Animals of North America,* some 60 papers in science and science education, and four films. He has served as a director of the National Association of Science Teachers, Treasurer and President of the Federation of Science Teachers Association of New York City, and at present is President of The Association of Chairmen of Biological Science. During his fifteen years of high school and college teaching, he has served on some thirty committees including syllabus and other professional committees. At present he is serving on The Curriculum Committee of the Chairmen's Association, New York City, the Special Bulletins Committee of the National Science Teachers Association, and a committee on Science Testing (College Entrance Board). He is a member of Phi Beta Kappa, Sigma Xi, and the National Association for Research in Science Teaching. His biography is listed in *Leaders in Education* and *American Men of Science.*

Dr. Ronald L. Ives is a native of Cleveland, Ohio. Degrees include a B.A. and M.S. from the University of Colorado, and M.A. and Ph.D. degrees from Indiana University. During World War II he served in the Chemical Warfare Service. His teaching experience includes Indiana University and the Airforce Radar School at Lowrey Airforce Base. A member of numerous scientific societies, he has published over two hundred technical papers in the fields of earth sciences, history and electronics. Presently he is chief physicist at Cornell Aeronautical Laboratory, Buffalo, New York.

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Auborn Russ Hall is a native of Prattville, Alabama. She has a B.A. degree from Huntingdon College, Montgomery, Alabama. She served as a Laboratory Technician in the U. S. Navy during World War II. She is now Biological Technician with the U. S. Public Health Service, Montgomery, Alabama.

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DR. HAROLD J. ABRAHAMS is a native of Philadelphia, Pennsylvania. He has a B.S. and Ph.D. degrees in Chemistry from the University of Pennsylvania. Teaching experience includes the University of Pennsylvania and Philadelphia Public High Schools. Presently he is teaching chemistry in the Central High School. His publications include about thirty articles in numerous publications and a book in preparation *Fundamentals of Chemical Computations*. He is a member of a number of professional education and scientific organizations.

DR. HUGH BERNARD WOOD is a native of Angola, Indiana. He has a B.S. degree from the University of Toledo, an M.A. degree from the University of Colorado, and an Ed.D. degree from Columbia University. During the War he served in the U. S. Navy. Teaching experience includes New Rochester, Ohio; Lark School, Toledo, Ohio; La Carne, Ohio; Victor, Colorado; Hudson College, Jersey City, New Jersey; Teachers College, Columbia University; Alabama Polytechnic Institute, Auburn, Alabama; and presently at the University of Oregon. He is co-author (with H. B. Bruner) of *What the Schools Are Teaching*. He is a member of numerous professional organizations and is the author of numerous articles.

DR. HOWARD IMPEVOCEN has a B.S. degree from the Northern State Teachers College, Aberdeen, South Dakota, and M.Ed. and Ed.D. degrees from the University of Oregon. Teaching experiences includes rural and small town schools in South Dakota, high schools in Portland, Oregon, Northern State Teachers College at Aberdeen, South Dakota and Registrar at Multnomah College, Portland, Oregon.

DR. ARTHUR H. BRYAN is a native of Brighton, Washington. He has a B.S. degree from Washington State College, a V.M.D. degree from the University of Pennsylvania, and an M.A. degree from the University of Maryland. Teaching experience includes Baltimore City College, University of Maryland, and University of Baltimore. Military service includes World Wars I and II. Publications include more than ninety articles and *Principles and Practice of Bacteriology* published by Barnes and Noble.

CHARLES WILFORD JOHNSON has a bachelor's degree from Illinois State Normal University, Normal, Illinois, and a Master's degree from the University of Wisconsin. Teaching service at Lawrenceville, Illinois, was followed by military service in the army during World War II. More recently he has been associated with the Research Food Institute of Stanford University. He is the author of a number of articles in geography and conservation.

CHARLES W. CROMBIE is a native of North Dakota. He has a B.A. degree from Linfield College, McMinnville, Oregon and an M.Ed. degree from the University of Oregon. Teaching experience includes Washington High School, Portland, Oregon; Vanport Junior High School, Portland, Oregon; Ridgefield High School, Ridgefield, Washington; and presently at Wy'east High School, Hood River, Oregon.

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JOHN D. WOOLEVER is a native of Wilkes-Barre, Pennsylvania. He has B.S. and M.Ed. degrees from Wayne University. He has taught for four years in the Detroit elementary schools. During World War II he served with the U. S. Navy.

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BARBARA A. MCEWAN is a native of Milwaukee, Wisconsin. She has an A.B. degree from Carleton College, Northfield, Minnesota and has attended the University of Southern California. She is author of "Putting Life Into Life Science" in the November, 1950 *American Biology Teacher*.

DR. GORDON M. DUNNING is a native of Cortland, New York. He has a bachelor's degree from the State Teachers College, Cortland, New York; M.S. and Ed.D. degrees from Syracuse University, Syracuse, New York. Teaching experience nine years in the secondary schools of New York; New York State Agricultural and Technical Institute, Alfred, New York; State Teachers College, Indiana, Pennsylvania; and presently Biophysics Research Analyst, Division of Biology and Medicine, Atomic Energy Commission, Washington, D. C. Military service includes 51 months U. S. Army, Infantry, Parachute Infantry and United States Forces European Theatre, Education Division. A member of numerous scientific and professional organizations, he has contributed to *The Science Teacher, School Science and Mathematics,* and SCIENCE EDUCATION. He is author of the *Dunning Physics Test* published by the World Book Company.

FRED S. MONTGOMERY is a native of Memphis, Tennessee. He has A.B. and M.A. degrees from the University of Kansas. Teaching experience includes McPherson, Lawrence, and Paola, Kansas, schools. Presently he is Director of Visual Education and Assistant Professor of Education at the University of Kansas. He is a member of a number of professional organizations and has contributed several articles to various magazines.

ROBERT W. RIDGWAY is a native of Emporia, Kansas. He has a B.S. degree from Baker University, Baldwin, Kansas, and an M.S. degree from the University of Kansas. During the war he saw military service with the U. S. Infantry in Europe. He has taught and served as principal of the Baldwin High School, Baldwin, Kansas. Presently he is principal of the Neodesha High School, Neodesha, Kansas.

DR. KENNETH E. ANDERSON has previously been introduced in this column and is well-known by many readers of SCIENCE EDUCATION through his many articles it has been our privilege to publish. He is Director of the Bureau of Research and Service, School of Education, University of Kansas. One of his recent contributions is the *Anderson Chemistry Test* published by the World Book Company.

BOOK REVIEWS

SMART, W. M. *The Origin of the Earth.* New York (51 Madison Ave.): Cambridge University Press, 1951. 239 p. $2.75.

This book had its origin in a series of lectures delivered to members of the three fighting services during the last year of the Second World War. Few scientific speculations have so excited the curiosity of man as that of the origin of the earth and the solar system. For many generations most men accepted literally the Biblical account as variously interpreted by many different men. To many such Archbishop Ussher's seventeenth century calculation was most satisfying. Not so to the scientist. Following the Nebular Hypothesis of Leplace there have been a whole series of hypotheses: Chamberlin-Moulton theory, Jeans-Jeffreys tidal theory, the collision theory, the binary star theory, the fission theory, the cepheid theory, the nebular-cloud theory, the electromagnetic theory, and the nova theory. Peculiarly enough the Chamberlin-Moulton Planestimal theory most widely held in this country receives scant attention whereas the Jeans-Jeffreys Tidal theory has more often caught the fancy of the English. This is one of the few instances in science among English-speaking peoples where the country of origin seems to play a predominant role as to the theory held.

Actually scientists are less certain today as to the particular mode of earth origin than they were a decade or so ago. And in America today no theory is completely acceptable or possibly even approaches wide acceptance. American readers will find this an excellent popular approach to a most challenging question. The writer is a well-known English astronomer and writer.

SACKS, JACOB. *The Atom at Work.* New York: (15 E. 26th St.): The Ronald Press Company, 1951. 327 p. $4.00.

Because of its more immediate urgency and the spectacular associations the atomic bomb has received most attention by writers—newspapers, magazines and books, by radio commentators, and the common people as they read, listen, and contemplate the destructive potentialities of atomic war. But the peacetime everyday constructive uses of atomic energy may in the end be the phase that revolutionizes the economic and political world.

The major purpose of *The Atom at Work* is present the whole story of atomic energy in a readable and understandable style. The first half of the book is the history of the tremendous sweep of events which led up to Curies' discovery of radioactivity and from this to the time when scientists discovered how to break atoms apart and produce radioactivity.

The second half of the book is a progress report on how isotopes are being used today to make a better and more helpful world. Dr. Sacks shows how the chemist is using them in his laboratory for fundamental research; how the biologist has seized upon the use of radiation to produce a better and cheaper penicillin mold, to produce radioactive isotopes to fight against cancer, leukemia, and thyroid malfunction; how agricultural research workers hope to improve plant growth; how the businessman uses isotopes to eliminate static, locate defects in metals, make better rayon and tires, and so on.

The author is a scientist on the staff at Brookhaven National Laboratory, Long Island. Altogether this is probably the best popular treatment of atomic energy that has been published. It can be comprehended by persons with little or no background in chemistry and physics. The reviewer recommends it for the high school science library, to all science teachers—elementary, junior high school or senior high school, and to all readers desiring some acquaintance about an area so much in the news of today.

LEYSON, CAPTAIN BURR W. *Atomic Energy in War and Peace.* New York: E. P. Dutton and Company, Inc., 1951. 217 p. $3.75.

Atomic energy and its implications dominates both local and world planning and policies—economic, political, and military. It is the dominant force in world affairs. Our whole life—our future is inevitably entertwined with atomic energy—the atomic bomb and the hydrogen bomb. In a very real sense the atomic bomb is the world's most potent weapon for peace as in actuality it is potentially also the obliterator of much of civilization. No wonder world thinking and planning is dominated by the shadow of the atomic bomb.

Captain Leyson answers many questions about the production, problems, uses, and implications of the atomic bomb. There is a most readable chapter on the yet to be developed hydrogen bomb. Medical and industrial uses of atomic energy, bomb protection, civilian bomb defense are discussed. Effects of bombs and types of casualties are described. Methods of detecting atomic radiations are discussed.

There is an excellent glossary of atomic energy terms. Laymen, general science, biology, chemistry, and physics teachers will find the book quite readable and altogether authoritative.

ALLEE, W. C. *Cooperation Among Animals with Human Implications.* New York: Henry Schuman, Publisher, 1951. 233 p.

This is the revised edition of a book first published in 1941. One of the greatest advances of recent years has been the accumulation of scientific evidence that cooperation, not conflict, is a predominant principle of social behavior. In the opinion of some scientists, the application of this crucial knowledge to fundamental social relations may, in the long run, be vastly more significant than the development of atomic power.

Dr. Allee presents original and fresh evidence describing the principle of atomic cooperation as it operates in the animal world. Cooperative beginnings are demonstrated from one-celled protozoans to insects and to men. The author raises the question as to what extent do the underlying biological relationships tend to bring about war. Is war biologically justified by the results produced? Dr. Allee says, "Widely dispersed knowledge concerning the important role of basic cooperative processes among living beings may lead to the acceptance of cooperation as a guiding principle both in social theory and as a basis for human behavior. Such a development when it occurs will alter the course of human history."

DUNN, L. C. *Genetics in the 20th Century.* New York: The Macmillan Company, 1951. 634 p. $5.00.

This volume is a compilation of the invitation papers presented at the program of the Golden Jubilee of Genetics at Ohio State University, September 11–14, 1950. The celebration was in honor of the fiftieth anniversary of the rediscovery of Mendel's work which marked the beginning of the science of genetics. The book was edited for the Genetics Society of America. Twenty-six of the world's leading geneticists have contributed papers to this volume. Few, if any, of the papers are too technical for the layman. High school biology teachers and general science teachers will find this a most readable, accurate account of the present status of genetics.

BUTTERFIELD, HERBERT. *The Origins of Modern Science.* New York: The Macmillan Company, 1951. 187 p. $3.00.

This history of science covers the period 1300–1800 and should interest not only science teachers but general readers and students of the humanities. Great scientific movements characterize this period. The author shows not only the ways in which modern science developed but also how this development affected modes of thought. The author also shows how a careful study of science can help to bridge the gap between science and the humanities. Professor Butterfield considers the scientific revolution as one of the most important movements since the rise of Christianity. It transformed the whole diagram of the physical universe and the very texture of human life itself.

Altogether this is an unusually fine history of science and should be of great interest to laymen, general readers and secondary and college teachers of science.

HOWARD, A. V. *Chamber's Dictionary of Scientists.* New York: E. P. Dutton and Company, Inc., 1951. 250 p.

This is a concise, accurate, up-to-date volume on the lives and achievements of the men who have shaped the course of science. The names range from the beginnings of science as we know it with the Chaldees to the present day. The names are arranged alphabetically and often there is a photograph. A valuable feature of the book is the comprehensive index of topics, which enables the reader to trace those concerned with the discovery of radioactivity, studies in matter, or the origin of the moon and so on. For those persons wanting or needing to know something about the lives of scientists, this is a most practical biographical dictionary. There are some 1300 biographies.

COLLINS, JR., HENRY H. *Birds of Montezuma Castle and Tuzigoot National Monuments.* Bronxville, New York (136 Park View): Henry H. Collings, Jr., 1951. 14 p. $0.25.

This booklet on *Birds of Montezuma Castle and Tuziogoot National Monuments* is the first of a series planned for various national parks and monuments. The booklet is directed toward the average park visitor who has a potential rather than a developed interest in nature.

This first booklet of the series is certainly well written and the completion of the series on a similar high plane would constitute an unusually fine series on the birds of America. It is especially timely and practical for it is quite likely that visitors to parks are more likely to pay attention to the birds of the area than they may pay to the birds of their home area. Visitors will probably see more different birds in more areas at national parks than anywhere else as they travel about the country.

The illustrations in color as well as black and white by Roger Tory Peterson add much to the attractiveness of the booklet.

OPPE, GRETA. *Chemistry.* Austin, Texas: The Steck Company, 1951. 160 p. $0.80.

Chemistry is a combined worktext and laboratory manual. There are 58 laboratory experiments that cover the usual high school chemistry course, with a special emphasis on chemistry in modern living. The first five units presents the fundamental principles of chemistry and the last five units emphasizes applications.

The book can be used with any high school chemistry text. Each unit has an interesting preview with page cross-references to most present day chemistry texts. Then follow test exercises, experiments, review learning exercises, things pupils can do, questions for review, and so on. Pages are detachable.

Altogether the material is well selected and applicable to most chemistry classes not using the regular chemistry manual. There is a separately bound test for each unit as well as a final examination.

The author teaches chemistry in Ball High School, Galveston, Texas, and is one of America's better known science teachers through her activities in NSTA and NARST, and her contributions to *Science Education.*

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